READY FOR LIFE?

THE LITERACY ACHIEVEMENTS

OF IRISH 15-YEAR OLDS

WITH COMPARATIVE

INTERNATIONAL DATA

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Educational Research Centre

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Preface

In the past decade, Ireland has participated in several international studies of educational achievement, including the ~~'s~~Third International Mathematics and Science Study (TIMSS), organised by the International Association for the Evaluation of Educational Achievement (IEA), and the International Adult Literacy Survey (IALS), organised by Statistics Canada, and supported by the Organisation of Economic Cooperation and Development (OECD).~~, which was supported by the Organisation for Economic Co-operation and Development (OECD)~~ The outcomes of such studies~~, when set in an international comparative context,~~ can provide valuable information to individuals and organisations involved in all aspects of education, including policymakers and those ~~involved in~~responsible for developing, implementing and evaluating programmes. More specifically, the studies enable educators to consider the performance of Irish students and adults, and variables associated with their performance, in an international context.

In 2000, the first cycle of a new international assessment involving 15-year old students in second-level schools, the OECD Programme for International Student Assessment (PISA), was conducted in 28 OECD member countries (including Ireland) and in four additional countries. The primary function of PISA is to generate comparative international data on students' achievements in three domains – reading literacy, mathematical literacy and scientific literacy – and to inform the development of policy in participating countries on issues ~~that are~~ associated with achievement~~to them~~. Unlike earlier international assessments involving school-age populations, which sought to measure students' mastery of curricular content, PISA takes a literacy-based approach that seeks to measure the cumulative yield of education at the point at which compulsory schooling ends in most OECD countries, in terms of the knowledge and skills that students need in adult life.

In 2000, the primary focus of PISA was on measuring and describing students' achievements in reading literacy. Information on some aspects of students' achievement in mathematical and scientific literacy was also obtained. Associations between student social background and achievement were of particular interest. In future PISA cycles, it is planned to focus more strongly ~~more strongly~~ on mathematical literacy (2003)~~,~~ and ~~on~~ scientific literacy (2006), and to describe trends in achievement in the three aspects of literacy over time. It is also planned to address students' cross-curricular problem-~~-~~solving skills (2003) and their knowledge of information and communication technologies (ICTs) (2006).

At the international level, PISA 2000 was implemented by a consortium headed by the Australian Council for Educational Research (ACER) on behalf of OECD and participating member countries. In Ireland, ~~PISA~~ it was jointly implemented by the Educational Research Centre and the Department of Education and Science.

This national report is being published in conjunction with an international report detailing the outcomes of PISA 2000, *Knowledge and Skills for Life: First Results of PISA 2000* (OECD, 2001a). The purpose of the national report ~~was prepared and~~is to provide a more detailed interpretation of the performance of Irish students in the assessment~~PISA~~ than is possible in the more broadly focused international report, and to consider how the~~the~~ outcomes~~ of PISA~~ of PISA might contribute to the development of educational policy in Ireland. The report compares performance on the assessment~~PISA~~ with the performance of Irish students in earlier international studies, and examines links between the PISA assessment and the Junior Cycle syllabi/Junior Certificate Examination.~~ Junior Certificate E~~ The relationships between performance on ~~PISA~~ the assessment and a number of key student and school variables are described. In addition, more complex models of achievement in reading, mathematical, and scientific literacy, which seek to identify the combinations of variables that explain the performance of Irish students on the~~ PISA~~ assessments, are presented.

Thanks are extended to the principals, staff and students who participated in the PISA 2000 assessment. Without their co-operation and support this study would not have been possible. In total, 139 schools and almost 4,000 students participated in the ~~PISA 2000~~ main study (March 2000). We would also like to acknowledge the work of the 42~~0~~ members of the Inspectorate of the Department of Education and Science (six from primary level, and 36 from second level)~~,~~ who administered the assessments with a high degree of professionalism and commitment. Quality of assessment procedures was further assured by six senior members of the Inspectorate, who monitored the assessment in 21 of the 139 participating schools. Thanks are also due to the 27 schools and 900 students who participated in ~~the PISA 2000~~a field trial (March 1999), and whose responses and comments assisted greatly in the refinement of instruments and procedures for the~~ PISA 2000~~ main study.

We are greatly indebted to the members of the National Advisory Committee for PISA, who ~~have~~ provided invaluable advice and support on all aspects of the PISA project, from selection of assessment items to interpretation of student outcomes. In addition to the authors of this report, the ~~PISA 2000 National~~ Committee consisted of Carl Ó Dálaigh (Deputy Chief Inspector, Department of Education and Science, Chair), Declan Kennedy (National University of Ireland, Cork), Bill Lynch (National Council for Curriculum and Assessment), Tom Mullins (National University of Ireland, Cork), and Elizabeth Oldham (Trinity College, Dublin).

We acknowledge the considerable input of the Director of the Educational Research Centre, Thomas Kellaghan, who provided extensive guidance on substantive and editorial issues pertaining to this report. Thanks are also due to Mark Morgan and Séamus Ó hÚallacháin, also of the Centre, for their comments on earlier drafts of the report~~. Thanks~~, and to Séamus Ó hÚallacháin and Ursula Ní Dhálaigh for translation of the PISA 2000 instruments from English into Irish.

Thanks are extended to the PISA 2000 consortium, especially Ray Adams (Australian Council for Educational Research/ACER), Christian Monseur (ACER), Keith Rust (Westat, USA), and Andreas Schleicher (OECD), for advice on technical aspects of the project. We would also like to acknowledge Murray Aitkin (University of Newcastle, UK) for advice on weighting in generalized linear mixed models; James K. Lindsey (Limburgs Universitair Centrum, Diepenbeek, Belgium) for providing the Generalized Linear Interactive Modelling (GLIM) code that formed the basis of the missing values method used in the statistical models; and Mark Sofroniou (Wolfram Research Inc., US) for advice on numerical computation.

We acknowledge with thanks the work of the participants in the PISA Test-Curriculum Rating Project: Denis Bates, Maura Conneally, John Evans, Raymond Frawley, Declan Kennedy, Edward McDonnell, Hugh McManus, Tom Mullins, Elizabeth Oldham, Jim O'Rourke, George Porter, and Peter Tiernan.

Thanks are extended to colleagues at the Educational Research Centre for assistance with other aspects of the project: to Mary Rohan for administrative support throughout the implementation of PISA and the preparation of this report~~. Thanks~~; to John Coyle for support with software and for overseeing data entry and data cleaning~~. Thanks~~; and to Aiden Carthy and Michael O'Leary for their input ~~into PISA in its~~during the field trial and student marking phases. Finally, we wish to acknowledge the work of the fourteen individuals who marked students' responses to the PISA assessment; ~~due to~~ their diligence and attention to detail ensured a ~~,~~ high quality of marking~~ was assured.~~.

Executive Summary

The Programme for International Student Assessment (PISA) was administered to students in 28 OECD member countries (including Ireland) and in four additional countries in Spring/Autumn 2000. In Ireland, 3,854 15-year old students in 139 schools participated. In line with the literacy-based approach to assessment underpinning PISA, tests of literacy were administered to students in one major domain (reading), and in two minor domains (mathematics and science).

In the reading literacy assessment, students were tested on their understanding of a range of texts, both continuous (descriptions, narrations and essays) and non-continuous (charts, diagrams, maps, forms and tables). The outcomes are reported in terms of scores on an overall (combined) scale, and on three subscales – Retrieving information, Interpreting information in texts, and Reflecting on and Evaluating the content and structure of texts. Outcomes are also reported in terms of proficiency levels on the combined scale and on the three subscales.

Ireland achieved the fifth highest mean score among the 27 OECD countries that met agreed criteria on school and student participation levels. Just one country (Finland) achieved a significantly higher mean. The countries with mean scores not significantly different from Ireland's are Australia, Canada, Japan, Korea, Sweden, the United Kingdom, and New Zealand. The performance of Irish students on the Retrieve and Interpret subscales is about the same as on the test as a whole. Again, only students in Finland achieved significantly higher mean scores. Ireland ranked third on the Reflect/Evaluate subscale, with a mean score that does not differ significantly from Canada, the highest scoring country on the subscale. Ireland's mean scores on the combined scale and on the three subscales are significantly higher than the corresponding OECD country average scores.

Five proficiency levels were identified for the combined reading literacy scale and for each of the reading subscales. An additional category, 'below Level 1', was added to accommodate students whose performance did not meet the criteria for inclusion at Level 1 (the lowest level) ~~(Level 1)~~. In Ireland, 11.0% of students are at Level 1 or below; 17.9% at Level 2; 29.7% at Level 3; 27.1% at Level 4; and 14.2% at Level 5. Finland, the country with the highest mean score, has 6.9% at Level 1 or below and 18.5% at Level 5. The percentages of Irish students represented at each level on the Retrieve and Interpret subscales are broadly similar to the percentages on the combined reading literacy scale. Performance on the Reflect/Evaluate subscale is marginally better, with 44.0% of students achieving Levels 4 and 5, compared with an OECD average of 33.4%. The combined reading literacy scores of Irish students at the national 10th and 90th percentiles are among the highest in the OECD.

The assessment of mathematical literacy was less comprehensive than the assessment of reading literacy. Only two areas were included (Change and Growth, and Shape and Space; these encompassed aspects of Measurement, Algebra, Functions, Geometry, and Statistics). Performance was reported in terms of scores on a single scale only. The performance of Irish students on the scale does not differ significantly from the OECD country average. Ireland ranked 15th of 27 OECD countries. The highest scoring country (Japan) had a mean score that is over half a standard deviation higher than the mean of Irish students, while the United Kingdom achieved a mean score that is one quarter of a standard deviation higher. However, Irish students at the (national) 10th percentile achieved a score that is significantly higher than the OECD country average score at that marker, and ranked 14th. Irish students at the 90th percentile achieved a score that is below the corresponding OECD country average, and ranked 20th, indicating a relatively poor performance by higher-achieving students.

The assessment of scientific literacy, which was also less comprehensive than for reading literacy, sought to measure students' ability to apply a range of scientific processes including recognising questions, identifying evidence/data, and drawing and evaluating conclusions. While some content areas, such as Atmospheric Change, Earth and Universe, Energy Transfer, and Ecosystems, were well represented, others, such as Biodiversity, Chemical and Physical Change, and Physiological Change, were not. Like mathematical literacy, achievement in scientific literacy was reported on a single scale only.

The mean score of Irish students on the scientific literacy scale is significantly higher than the OECD country average. Ireland ranks 9th overall. Students in six countries, including the UK, Korea, and Japan, achieved significantly higher mean scores than Ireland, while students in five other countries, including Austria and Sweden, achieved mean scores that are not significantly different. Thus, Ireland did comparatively better in scientific literacy than in mathematical literacy, but relatively less well than in reading literacy. The scientific literacy score of Irish students at the (national) 10th percentile is above the corresponding OECD average. However, Irish students at the (national) 90th percentile achieved a score that is not significantly different from the OECD average at that point.

School and student questionnaires were administered to obtain information on a range of variables. These included student characteristics (such as gender, home educational climate, learning processes, reading habits, and attitudes to reading), and school characteristics (such as enrolment size, learning climate, and resource availability).

Female students outperformed male students on the combined reading literacy scale (by over two-fifths of a standard deviation), by and on each of the reading subscales. The gender difference is largest on the Reflect/Evaluate scale (over one-third of a standard deviation). Male students are more strongly represented than females at the lowest proficiency levels on the PISA combined scale and subscales, while the reverse pattern is apparent at the highest levels. Male students performed significantly better than female students (by one-sixth of a standard deviation) on the assessment of mathematical literacy. The gender difference difference is not statistically significant for scientific literacy.

Home background variables representing combined parents' socioeconomic status (SES), combined parents' educational level, home educational resources (access to a dictionary, a desk/place to study and textbooks) and number of books in the student's home (a measure of home educational environment) were correlated with achievement in the three assessment domains. Students in lone parent households achieved mean scores that are significantly lower (by about a quarter of a standard deviation in each assessment domain) than students not in lone parent households. There is an inverse relationship between the number of siblings in students' families and their literacy scores in all three domains.

The student reading habits and attitudes most strongly associated with combined reading literacy are attitude towards reading, frequency of leisure reading, diversity (range) of materials read, and frequency of borrowing library books. Students who hold positive attitudes towards reading achieved a mean combined reading literacy score that is one standard deviation higher than that of students who hold a negative attitude. The relationship between some of these variables and achievement is curvilinear rather than linear. For example, moderate amounts of leisure reading (30 to 60 minutes per day) are more strongly associated with achievement than larger amounts.

A number of other student characteristics were found to be associated with achievement. Students identified as being at risk of dropping out of school before doing the

Leaving Certificate Examination (14.3% of students) achieved a mean combined reading literacy score that is over one standard deviation lower than that of students not deemed to be at risk. Students at risk of dropout also achieved mean scores in mathematical and scientific literacy that are substantially lower than the mean scores of students not at risk. Students attending learning support classes in English achieved a mean score that is ~~over~~over one standard deviation lower than that of students not attending such classes, and also performed less well in mathematical and scientific literacy. Students who did not study science at Junior Cycle level performed less well (by almost three-quarters of a standard deviation) on the assessment of scientific literacy than students who studied science. However, the mean scientific literacy score of students who studied Ordinary level science at Junior Cycle is not significantly different from the mean score of students who did not study science at Junior Cycle. Students who completed homework mostly or always on time ~~on most occasions or always~~ did significantly better in all three assessment domains than students who completed homework on time on a less frequent basis. Students who had access to a calculator during the ~~PISA~~ mathematical literacy assessment (27.3% of students) achieved a mean score that is over one quarter of a standard deviation higher than that of students without access.

Several school characteristics were found to be associated with achievement ~~on PISA~~ ~~including~~ and included the following: school enrolment size (students in larger schools achieved significantly higher mean scores in combined reading literacy than students in smaller schools; differences in mathematical and scientific literacy were not significant); school type (students in community/comprehensive schools achieved significantly higher mean scores than students in vocational schools in the three assessment domains, and significantly lower scores than students in secondary schools in reading and scientific literacy, but not mathematical literacy); disadvantaged status (students in schools designated as disadvantaged achieved mean scores in the three assessment domains that are about one-half of a standard deviation ~~higher~~ lower than the mean scores of students in non-designated schools); and gender composition (students in all-boys schools achieved significantly higher mean scores than students in co-educational schools in mathematical and scientific literacy but not in reading literacy, while students in all-girls schools outperformed students in co-educational schools on reading literacy, but not mathematical or scientific literacy).

Students in small classes did significantly less well (by about one-quarter of a standard deviation) in all three assessment domains than students in average-sized classes, while no differences in mean achievement were observed between students in average-sized and large-sized classes in any of the domains. Achievement is not associated with different levels of student-teacher ratio, except in the case of mathematical literacy, where students in schools with a high student-teacher ratio did significantly better than students with a medium student-teacher ratio. Students in schools with high levels of negative student behaviour (a measure provided by school principals) did significantly less well on combined reading literacy and scientific literacy than students in schools with average levels. The mean mathematical literacy scores of students in schools with varying levels of negative disciplinary climate (a measure provided by individual students, but aggregated to the school level) do not differ significantly, while students in schools with a high negative disciplinary climate had significantly lower mean scores in reading and scientific literacy, compared with students in schools with an average negative disciplinary climate.

Since many of the variables that correlated with achievement are themselves inter-related, regression-based procedures were used to help improve inferences about the relative contributions of such variables to achievement at both school and student levels.

The percentage of between-school variance in Irish student achievement is 17.8% for combined reading literacy; 11.4% for mathematical literacy; and 14.1% for scientific literacy. These estimates are well below the corresponding OECD country average percentages and suggest that, compared to schools in other countries, Irish schools are relatively homogeneous with respect to achievement, but there is considerable variation in achievement within schools.

Hierarchical linear models were developed for all three domains in which student performance was assessed. The final model for reading literacy explains 77.8% of between-school variance and 44.2% of within-school variance. The corresponding model for mathematical literacy explains 78.8% of between-school variance and 31.9% of within-school variance, while that for scientific literacy explains 74.5% of between-school variance and 34.1% of within-school variance. The larger proportion of within-school variance explained in the final reading model may be attributed to the inclusion in the model of a number of variables that are specific to reading literacy, including attitude towards reading and frequency of leisure reading.

The model for reading literacy includes school-level variables (disciplinary climate, school type and disadvantaged status), student-level variables (gender, socioeconomic status, number of siblings, index of books in the home, dropout risk, frequency of absence from school, completion of homework on time, grade level, frequency of leisure reading, and attitude to reading), and a variable reflecting the interaction between gender and index of books in the home. This model confirms the associations of a number of variables with achievement and indicates their estimated contributions to students' scores. The variables include attendance at a vocational rather than a community/comprehensive school (–20.4 points or 0.22 of a standard deviation); attendance at a school designated as being educationally disadvantaged (–22.3 points or almost one quarter of a standard deviation); and dropout risk (–54.4 points, or over half a standard deviation).

Since the model is additive, it is possible to estimate the contributions of combinations of variables. For example, ~~it can be estimated that~~ a student attending a vocational school that is designated as disadvantaged and who is at risk of dropping out of school ~~will~~ is expected to score, on average, 97.1 points lower in reading literacy~~, than~~ compared with a student attending a community/comprehensive school that is not designated, and who is not at risk of dropping out. The (average) contribution of socioeconomic status (SES) ranges from +25.9 points (one quarter of a standard deviation) for students categorised as having high SES (i.e., those in the top third of the distribution of SES scores) to +3.0 points for students categorised as having low SES (those in the bottom third).

The hierarchical linear models for mathematical literacy and scientific literacy are~~were~~ less complex than that for reading literacy. School type and disadvantaged status are the only school-level variables in these models. However, together they account for sizeable proportions of between-school variance. Both models also include parents' combined ~~educational attainment, student lone-parent status~~socioeconomic status, number of siblings, index of books in the home, grade level, completion of homework, and dropout risk. ~~In the mathematical literacy model, there was a significant interaction between gender and books in the home that was broadly similar to that found in the reading literacy model.~~

In the model for mathematical literacy, the~~The~~ effect of socioeconomic status is estimated to amount to ~~+47.7~~+41.7 score points (just over half a ~~two~~ standard deviation~~s~~) for high SES students, +30.84 for medium SES students, and +20.1 for low SES students. Hence, the contribution of this variable is comparatively greater than for reading literacy, even though combined parental educational attainment is also included in the model.

In addition to the variables included in the model for mathematical literacy, the model for scientific literacy includes a variable describing whether or not a student studied science at school. The contribution of studying science to students' scores on the scientific literacy test is +43.1 points (almost half a standard deviation).

Correlations between the grades of students on the Junior Certificate Examination (represented as scores on an Overall Performance Scale in English, Mathematics and Science) and their scores on the PISA assessment domains are moderately strong. The correlation between Junior Certificate English and PISA reading literacy is .74; the correlations between Junior Certificate Mathematics and PISA mathematical literacy, and between Junior Certificate Science and PISA scientific literacy, are both .73.

In an examination of links between aspects of the Junior Cycle syllabus/Junior Certificate Examination and PISA, curriculum experts in Ireland indicated that the processes underlying the majority of PISA reading literacy items would be very familiar to students studying Higher and Ordinary level syllabi, and that, for most students, the contexts in which items were presented would be very familiar or familiar. It was concluded that the format of the items would be unfamiliar to a majority of students at all three syllabus levels.

Mathematics curriculum experts concluded that students taking Higher and Ordinary level Mathematics would be unfamiliar with the concepts underlying about one-third of the PISA mathematical literacy items, and that Foundation level students would be unfamiliar with the concepts underlying about half the items. It was concluded that students at all syllabus levels would be unfamiliar with the context of application in which around four-fifths of the items were presented, and would also be unfamiliar with the format of at least half the items.

Curriculum experts in science concluded that, while most students would at least be familiar (if not very familiar) with the processes underpinning the PISA scientific literacy items, students at both Higher and Ordinary levels would be unfamiliar with the concepts underlying about half of the items and with the contexts in which about four-fifths of items were presented. The formats of two-fifths of the items were judged to be unfamiliar to students.

Correlations between students' combined reading literacy scores and the three curriculum rating scales (familiarity with process, context, and format) suggest that all three scales correlate moderately strongly with achievement (range = .46 to .55). In contrast, the scale most closely associated with achievement in mathematical literacy is the familiarity with concept scale (r = .48); correlations associated with the context (.23) and format (.20) scales are lower. In the case of scientific literacy, the familiarity with concept scale is also most closely associated with achievement (r = .19), while correlations associated with the process, context and format scales are considerably smaller (range = –.01 to .06). For mathematical literacy, at least, it appears that understanding of the concept underlying an item is more important than how the item is contextualised, or the format in which the item is presented.

In the report, comparisons are drawn between the performance of Irish students on PISA and in other international studies of educational achievement, taking into account such factors as assessment frameworks, item formats, and criteria associated with proficiency levels. Some preliminary implications of the outcomes of PISA for education in Ireland are offered.

Introduction

The first cycle of the OECD Programme for International Student Assessment (PISA) was implemented in 2000, when representative samples of 15-year olds enrolled in school- and work-based educational programmes in 28 OECD countries, including Ireland, and four additional countries, sat tests of reading literacy, mathematical literacy and scientific literacy. The students and the principal teachers of their schools completed questionnaires that sought information about the home characteristics of the students, and the contexts in which teaching and learning occurred.

PISA was designed by representatives of OECD countries to provide indicators of the achievement of students in key aspects of literacy at or near the end of compulsory schooling (age 15). The assessment purports to be forward looking in that it seeks to measure knowledge and skills regarded as necessary for future learning and effective participation in society. No explicit attempt was made at the international level to link existing school curricula to the PISA assessments, or to the performance of students on the assessments. However, in Ireland, links between Junior Cycle syllabi in English, mathematics, and science were examined, and the performance of students on the PISA assessment and Junior Certificate Examination was compared.

In 2000, reading literacy was the major domain of assessment. In subsequent assessments, mathematical literacy (2003) and scientific literacy (2006) will be major domains. The frameworks underpinning the tests of literacy were developed by international panels of subject experts, and may be regarded as reflecting the most up to date position with respect to assessment in the three domains. A notable feature of the reading literacy framework is the inclusion of a reading process strand dealing with reflection on, and evaluation of, the content and structure of texts.

The assessment instruments comprised multiple-choice items and ones that require constructed responses. Whereas in earlier international studies up to 75% of items were of the multiple-choice variety, in PISA fewer than 50% of items fell into this category. An important feature of some of the open constructed-response items is that divergent responses and opposite viewpoints were acceptable. Another important feature is the awarding of partial credit for partially-correct responses.

The implementation of a literacy-based approach to assessing mathematics and science resulted in the development of some units that included substantial amounts of text. Their inclusion would have disadvantaged lower-achieving readers, as they would be unable to access the text. In this context, it may be noted that the texts used to assess scientific literacy were, on average, somewhat more difficult to read than those used to assess reading literacy.

Using techniques designed to ensure nationally representative samples, schools in countries participating in PISA were stratified on the basis of the number of 15-year olds enrolled. In Ireland, 154 schools (including those in the secondary, community/ comprehensive and vocational sectors) were selected and invited to participate. A total of 139 schools agreed to do so. Within each participating school, up to 35 students were selected. A total of 3,854 students attempted the assessment. Both school and student response rates exceeded agreed international standards. A rotated booklet design was used so that each student was asked to complete just a portion of the pool of assessment items. While all booklets included some reading literacy units and questions, just over one half included mathematical and/or scientific literacy items.

The analysis of the PISA data involved the use of statistical procedures that took into account the complex nature of the sample design. In addition to descriptive analyses (which included comparisons with the performance of students in other countries), an attempt was made to describe the relative contributions of a range of school- and student-level variables to student performance. This involved the use of hierarchical linear modelling techniques to construct parsimonious explanatory models of performance in the three assessment domains.

Particular care should be exercised in interpreting the outcomes of international studies of educational achievement. A country's rank order is a crude measure of performance, and tells little about whether the performance of a country is significantly different from that of another country or from the international average, how achievement is distributed within a country, or what variables account for reported patterns of achievement. However, when interpreted with care, such information can provide valuable insights into a country's education system in a comparative context.

ORGANISATION OF THIS REPORT

There are seven chapters in this report. In Chapter 1, the content of the PISA assessment is described, and the implementation of the study in Ireland is outlined. In Chapter 2, a context for the PISA assessment is established through a review of findings of earlier international studies of educational achievement, and a consideration of variables associated with achievement in these studies. Chapter 3 describes the performance of Irish students on the assessments of reading literacy, mathematical literacy and scientific literacy, with reference to the performance of students in other OECD countries. Chapter 4 examines relationships between school- and student-level explanatory variables and the performance of Irish students in the three literacy domains. Chapter 5 seeks to explain variation in student performance using multilevel models that describe relationships between explanatory and response (achievement) variables. Chapter 6 compares Junior Cycle curricula in Irish second-level schools with the assessment frameworks in PISA, and examines relationships between the achievements of third year second-level students on the PISA assessment and their performance on the Junior Certificate Examination. In Chapter 7, conclusions arising from the analyses presented in the report are drawn, and implications for policy are suggested.

THE OECD/PISA INTERNATIONAL REPORT

Readers of this report may also wish to refer to the international report on PISA, *Knowledge and Skills for Life: First Results of PISA 2000* (OCED, 2001a). The international report provides an overview of the PISA approach to assessing literacy, presents a detailed profile of student proficiency in reading literacy in participating countries, summarises the performance of students in mathematical and scientific literacy, and examines motivational and attitudinal variables associated with achievement. In addition, the report explores gender differences in achievement, examines relationships between a wide range of student background variables and achievement, and describes associations between the learning and school environments of students and their achievement. The report concludes with a comparison of the relative contributions of different school and student level variables (including socioeconomic status) to achievement in participating countries, and a presentation of implications for policy development.

1

The OECD Programme for International Student Assessment (PISA): Overview and Implementation

The first cycle of the OECD Programme for International Student Assessment (PISA) was implemented in the year 2000. Representative samples of 15-year olds enrolled in school- and work-based educational programmes in 28 OECD countries, including Ireland, and four additional countries, sat tests of reading literacy, mathematical literacy and scientific literacy (Inset 1.1). In addition, the students and the principal teachers of their schools completed questionnaires that sought information about the home characteristics of the students, and the contexts in which teaching and learning occurred.

Inset 1.1. Countries Participating in PISA 2000

	OECD Countries		*Non-OECD Countries*
Australia	Hungary	Norway	Brazil
Austria	Iceland	Poland	Latvia
Belgium	Ireland	Portugal	Liechtenstein
Canada	Italy	Spain	Russian Federation
Czech Republic	Japan	Sweden	
Denmark	Korea	Switzerland	
Finland	Luxembourg	United States	
France	Mexico	United Kingdom	
Germany	New Zealand		
Greece	Netherlands*		

* The school response rate for the Netherlands was too low to permit the computation of reliable student achievement estimates.

The primary focus of PISA 2000 was on the assessment of reading literacy skills. Mathematical literacy and scientific literacy were treated as minor domains; only a limited number of aspects were assessed (see below). In future assessments, these areas will assume the status of major domains, while reading literacy will become a minor domain (Inset 1.2). It is also planned to include the assessment of students' cross-curricular problem-solving skills, and a comprehensive measure of students' familiarity with information and communication technologies in future PISA cycles.

The policy concerns of participating countries were evident in the Student and School questionnaires used in PISA 2000. The School questionnaire focused on school management, organisational and resource variables that may be associated with performance, while the Student questionnaire sought information on equity-related matters (e.g., socioeconomic status, parents' education), students' attitudes towards and engagement in reading, and their use of self-regulated learning strategies.

Unlike earlier international assessments involving school-age populations, which sought to measure students' mastery of curricular content, PISA seeks to measure the cumulative yield of education at the point at which compulsory schooling ends in most OECD countries, in terms of the knowledge and skills that students need in adult life. In line with this focus, a 'literacy-based' approach to conceptualising and assessing students' knowledge and skills is adopted. This involves assessing students' ability to identify evidence, to reason, and to solve problems in concrete situations (represented by complex texts). The key features of PISA 2000 are outlined in Inset 1.3.

Inset 1.2. Focus of PISA 2000 and Subsequent Planned Assessment Cycles

Year	*Major Domain*	*Minor Domains*	*Additional Areas of Interest*[*]
2000	Reading Literacy	Mathematical Literacy Scientific Literacy	Equity and literacy; Reading attitudes and habits; Students' self-regulated learning
2003	Mathematical Literacy	Scientific Literacy Reading Literacy Cross-Curricular Problem Solving	Variables associated with performance in mathematical literacy; Attitude to mathematics
2006	Scientific Literacy	Reading Literacy Mathematical Literacy	Information and Communication Technologies; Attitude to science

[*]These areas are addressed through the administration of questionnaire items.

Inset 1.3. Key Features of the PISA 2000 Assessment

- An internationally standardised assessment of 15-year olds, jointly developed by participating countries and administered to over 250,000 students in 32 countries
- A focus on how young people near the end of compulsory schooling can use their knowledge and skills to meet real-life challenges
- An emphasis on the mastery of processes, the understanding of concepts, and the ability to function in various situations, within each assessment domain
- The administration of paper-and-pencil assessments involving both multiple-choice items, and items requiring students to construct their own answers
- The development of a profile of skills and knowledge among students at or near the end of compulsory schooling
- The development of contextual indicators relating results to student and school characteristics
- The development of trend indicators that can track changes over time

The PISA assessment can be viewed against the backdrop of other work conducted by the OECD, such as the regular gathering and publication of educational indicators (see, for example, OECD, 2001b). Such indicators provide information on human and financial resources invested in education, on how education and learning systems operate and evolve, and on the individual, social and economic returns to educational investment. PISA will enhance this work by providing international data on educational outcomes on a regular basis, at the point at which compulsory schooling ends in most OECD countries (i.e., about age 15).

PISA can also be situated in the context of current interest in the relationship between human capital and economic development, as economies become more knowledge-based and skills acquired at one point in time may become obsolete. According to OECD (1998), human capital can be defined as 'the knowledge, skills, competences and other attributes embodied in individuals that are relevant to economic development' (p. 9). The results of the International Adult Literacy Study (IALS), which was organised by Statistics Canada and subsequently supported by the OECD, indicate a relationship between an aspect of human capital (measured by performance on a test of reading literacy) and economic outcomes, at least at the individual level (see OECD/Statistics Canada, 2000; Morgan, Hickey, & Kellaghan, 1997). IALS and, to a lesser extent, PISA, address issues such as the adequacy of human capital investment (i.e., investment in education and training), the distribution of investment in human capital, equity in access to and use of human capital, and preparedness for and access to life-long learning.

PISA differs somewhat from other international studies of educational achievement involving school-age populations in which Ireland has participated, such as the Third International Mathematics and Science Study (TIMSS) (Beaton et al., 1996a, 1996b). First, PISA was designed in response to the policy needs of participating OECD countries, and its design and administration are overseen by a board consisting of representatives of participating countries which sets a policy-related agenda. Second, PISA implemented stringent procedures in areas which have been problematic in earlier international studies of achievement, such as translation of assessment instruments, implementation of assessment procedures, and data handling. Third, PISA has developed an ambitious reporting programme that includes the co-ordinated publication of initial international and national reports, and the publication of a series of policy-related thematic reports.

The remainder of this chapter is divided into four parts. In the first, the assessment of literacy in PISA is described with reference to the types of items used, the frameworks for reading literacy, mathematical literacy and scientific literacy, and the readability of texts and items. In the second part, PISA student and school questionnaires are described. The third part describes the implementation of PISA in Ireland and focuses on such matters as sampling schools and students and monitoring the implementation of assessment procedures. The fourth part describes some of the procedures used to analyse PISA data.

THE ASSESSMENT OF LITERACY IN PISA

PISA involves the assessment of students' knowledge and skills in three cognitive domains: reading literacy, mathematical literacy and scientific literacy. In this section, item types and the frameworks underpinning the three assessment domains are described.

Item Types

Two broad categories of items were used: multiple-choice (44.7% of all items), which required students to select the correct answer(s) from among several alternatives, and constructed response (55.3%), which asked students to provide written answers to questions. A distinction is made between simple multiple-choice items, where the student had to select one correct response from among several, and complex multiple-choice items, where the student had to respond to several options within an item (for example, a series of yes/no questions). Constructed response items are subdivided into short-response items (where the answer might consist of a single word or number), close-constructed response items (where longer responses are required, but the range of acceptable answers is necessarily limited), and open-constructed response items (where divergent responses and opposite viewpoints are acceptable). Partial credit was available on some of the constructed-response items. Examples of the different item types and scoring keys in each of the assessment domains are provided in Appendix 1.

Reading Literacy Framework

Reading literacy in PISA is defined in a broad sense. It does not measure whether 15-year old students are 'technically' able to read (i.e. whether or not they can recognise words in written text). Rather, assuming that they can, it attempts to assess the ability of students to understand and reflect on a wide range of written materials, in the context of different situations in which they are likely to encounter such materials at and beyond school. Reading literacy is defined as

> understanding, using and reflecting on written texts, in order to achieve one's goals, to develop one's knowledge and potential, and to participate in society. (OECD, 1999b, p. 20)

In addition to basic understanding of texts, this definition draws attention to higher-order reading comprehension skills including using and reflecting on texts. Reference to participation in society emphasises the role of reading literacy in economic, political, cultural, occupational, and social life.

In the context of operationalising this definition, reading literacy is defined in terms of three dimensions: the content or structure of texts; the processes that need to be performed; and the context in which knowledge and skills are drawn on or applied.

Text Content/Structure

In PISA, students' understanding of two text types – continuous and non-continuous – was assessed. Continuous texts consist of sentences arranged in paragraphs, which, in turn, may be arranged into longer texts such as sections, chapters or books. Non-continuous texts are frequently organised in matrix format, based on combinations of lists, and include charts and timetables.

Continuous and non-continuous texts were further subdivided into 11 text types. The first five are examples of continuous texts, while the remainder are examples of non-continuous texts. The text types (with examples in parentheses) are:

(i) Description (descriptions of persons, places or objects);
(ii) Narration (stories, reports, news articles);
(iii) Exposition (essays, definitions, explications, summaries);
(iv) Argumentation/Persuasion (comment, scientific argumentation);
(v) Injunction (instructions, rules, regulations, statutes);
(vi) Advertisements (invitations, summonses, warnings, notices);
(vii) Charts and graphs;
(viii) Forms;
(ix) Maps;
(x) Schematics (diagrams accompanying technical descriptions and expository text);
(xi) Tables (timetables, spreadsheets, indexes).

Reading Processes

PISA divides reading processes into three broad categories:

(i) Retrieving information (locating one or more pieces of information in a text);
(ii) Developing an interpretation (constructing meaning and drawing inferences using information from one or more parts of the text); and
(iii) Reflecting on and evaluating the content and form of texts (relating a text to one's experience, knowledge and ideas).

Reading Contexts

Context refers to the uses and purposes for which texts were constructed. The situations in which reading takes place, defined as how the author intended the text to be used, include:

(i) reading for private use;
(ii) reading for public use;
(iii) reading for work (occupational); and
(iv) reading for education.

These three dimensions were brought together in a series of texts (48 in all), and a number of tasks (items) were developed, based on each text. Altogether, there are 141 items. In reading literacy, almost two-thirds of items were based on continuous texts while the remainder were based on non-continuous texts (Table 1.1). Across all text types, the greatest number of items was based on expository texts (22.7%), narrative texts (12.8%), and argumentative/persuasive texts (12.8%). Charts/graphs and tables (9.2%) were also strongly represented. Almost one half of reading literacy items assessed students' ability to interpret information, 29.8% assessed ability to retrieve information, and 20.6% assessed ability to reflect on and evaluate the structure and content of texts.

Table 1.1. Distribution of Reading Literacy Items by Dimensions of the Reading Literacy Framework

Dimension	*Number of Items*	*Percent of Items*	*Dimension*	*Number of Items*	*Percent of Items*
Text Structure			***Reading Process***		
Continuous	89	63.1	Interpreting	70	49.6
Non-continuous	52	36.9	Reflecting/Evaluating	29	20.6
			Retrieving information	42	29.8
Text Type					
Advertisements	4	2.8	***Reading Context***		
Argument/Persuasive	18	12.8	Educational	39	27.7
Charts/Graphs	16	11.3	Occupational	22	15.6
Descriptive	13	9.2	Personal	26	18.4
Expository	31	22.0	Public	54	38.3
Forms	8	5.7			
Injunctive	9	6.4	***Total***	141	100.0
Maps	4	2.8			
Narrative	18	12.8			
Schematics	5	3.5			
Tables	15	10.6			

Mathematical Literacy Framework

The mathematical literacy domain is concerned with the capacity of students to draw upon their mathematical competencies to meet the challenges of the future. It is concerned with students' capacities to analyse, reason, and communicate ideas effectively by posing, formulating, and solving problems in a variety of situations. Mathematical literacy is defined as

> an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded mathematical judgements and to engage in mathematics, in ways that meet the needs of that individual's current and future life as a constructive, concerned and reflective citizen. (OECD, 1999b, p. 41)

The term ‘mathematical literacy’ and its definition suggest a shift away from a focus on what is taught in mathematics curricula in schools to the use of mathematical knowledge in a range of contexts, in ways that call for reflection and insight. However, the mathematical terminology, facts, procedures, and skills that are learned in school will be needed to deal with tasks that students encounter in PISA.

Reference in the definition to ‘the world’ includes the natural, social, and cultural settings in which an individual lives. The phrase ‘to engage in mathematics’ is intended to convey involvement in such activities as communicating, taking a position towards, relating to, and appreciating mathematics. The definition implies ability to use mathematics in a broad range of situations, including ones in which purely mathematical problems are presented, as well as ones in which no mathematical structure is evident, and must, therefore, be inferred. The definition and accompanying framework are heavily influenced by the ‘realistic mathematics education’ movement, which stresses the importance of solving mathematical problems in real-world settings (e.g., Freudenthal, 1973, 1981).

The definition of mathematical literacy is operationalised with reference to four dimensions: mathematical competencies, mathematical themes or ‘big ideas’, mathematical curricular strands, and situations and contexts.

Mathematical Competencies

PISA recognises eight mathematical competencies or skills:[1]

(i) Mathematical thinking;
(ii) Mathematical augmentation;
(iii) Modelling;
(iv) Problem posing and solving;
(v) Representation;
(vi) Symbolic, formal and technical skill;
(vii) Communication;
(viii) Use if aids and tools.

In recognition of the possibility that students may use several of these competencies simultaneously as they solve problems, and in order to facilitate the construction of items, mathematical competencies are organised into three classes:

(i) Class 1: reproduction, definitions and computations;
(ii) Class 2: connections and integration for problem solving;
(iii) Class 3: mathematical thinking, generalisation, and insight.

Each of the eight competency skills referred to earlier is viewed as playing a role in all three competency classes. Moreover,

> … the classes form a conceptual continuum from simple reproduction of facts and computational skills to the competency of making connections between different strands in order to solve real-world problems, to the third class, which involves mathematisation of real-world problems and reflection on the solutions, using mathematical thinking, reasoning and generalisation. (OECD, 1999b, p. 44)

[1] Full definitions of these competencies may be found in OECD (1999b).

Mathematical Themes

The content of PISA mathematical literacy centres around a series of themes or 'big ideas'. These include chance, change and growth, space and shape, quantitative reasoning, uncertainty, and dependency and relationships. Because mathematical literacy is a minor domain in PISA 2000, just two themes are included:

(i) Change and growth, which includes such aspects of mathematics as relationships and functions and their graphical representations, series and gradients, and aspects of number theory such as Fibonacci numbers and the Golden Ratio. Also included are aspects of geometry such as similarity and congruence, the growth of an area in relation to the growth of the perimeter or circumference, the representation of growth in algebraic and graphic forms, and aspects of data analysis and statistics.

(ii) Shape and space, which includes understanding of the relative positions of objects, relationships between shapes and images or visual representations, representation of three-dimensional objects in two dimensions, and the nature of perspective and how it functions.

Mathematical Strands

Traditional strands of mathematics curricula are included as minor organising themes. They serve to ensure a reasonable balance of items and a reasonable spread of content in relation to mathematics curricula. The curricular strands covered in PISA 2000 are: number, measurement, estimation, algebra, functions, geometry, and statistics.

Mathematical Situations

Situations or contexts in which problems are presented are also included in the PISA mathematical literacy framework. Situations include personal life, school life, work and sports, local community, society as encountered in everyday life, and scientific contexts. Situations are designed to be authentic, insofar as this can be achieved on a paper-and-pencil test, and to relate to aspects of everyday life.

Table 1.2. Distribution of Mathematical Literacy Items by Dimensions of the Mathematical Literacy Framework

Dimension	*Number of Items*	*Percent of Items*	*Dimension*	*Number of Items*	*Percent of Items*
Mathematical Theme			***Competency Class***		
Growth and change	18	56.3	Class 1	10	31.2
Shape and space	14	43.8	Class 2	20	62.5
			Class 3	2	6.3
Mathematical Strand			***Situation (Context)***		
Algebra	5	15.6	Community	4	12.5
Functions	5	15.6	Educational	6	18.8
Geometry	8	25.0	Occupational	3	9.4
Measurement	7	21.9	Personal	12	37.5
Number	1	3.1	Scientific	7	21.9
Statistics	6	18.8			
			Total	32	100.0

These dimensions are brought together in a set of 16 mathematical problems (scenarios embedded in 'real life' contexts), each of which is accompanied by one or more items. In all, there are 32 items. Of these, 56.3% are based on the theme of growth and change, while the remainder refer to shape and space (Table 1.2). The majority of the items (62.5%) are categorised as being in Competency Class 2. Just 2 of the 32 items are categorised as Competency Class 3. Compared to the proportion of Competency Class 2 items, there are relatively few Competency Class 1 items (which deal with more basic mathematical knowledge). The distribution of items across mathematical strands indicates that almost half of the items come from the areas of geometry and measurement, while just one is from the area of number. The discrepancy between the numbers of items in the assessments of reading literacy (141) and of mathematical literacy (32) indicates the minor status of mathematical literacy in PISA 2000.

Scientific Literacy Framework

PISA is concerned with the capacity of students to draw appropriate and guarded conclusions from evidence and information given to them, to criticise the claims made by others on the basis of evidence put forward, and to distinguish opinion from evidence-based statements. The ability to apply such processes in the context of science gives rise to the concept of 'scientific literacy'. According to PISA, scientific literacy is

> the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions, in order to understand and help make decisions about the natural world and the changes made to it through human activity. (OECD, 1999b, p. 60)

The use of the term 'scientific literacy' implies that scientific knowledge (knowledge about science) and scientific processes are both important. Indeed, the ability to apply scientific processes is viewed as requiring scientific knowledge, in the same way as the ability to engage in mathematical processes (mathematisation) requires knowledge of mathematical terminology, facts, and procedures. In PISA, scientific knowledge is not limited to facts, names, and terms. It also includes an understanding of fundamental scientific concepts, the limitations of scientific knowledge, and the nature of science as a human activity. Reference in the definition to understanding and helping to make decisions implies that understanding of the natural world is important for making decisions, and that scientific understanding can contribute to, but rarely determines, decision making. The term 'natural world' is used as shorthand for the physical setting, living things, and the relationships among them. Decisions about the natural world include those associated with science related to self, family and community, and global issues. 'Changes made through human activity' refer to planned and unplanned adaptations of the natural world for human purposes and their consequences.

The PISA scientific literacy framework includes four dimensions: science processes, science themes, science areas, and science contexts.

Science Processes

In PISA, five science processes are assessed:

(i) Recognising scientifically investigable questions (e.g., distinguishing between questions that may or may not be answered by scientific investigation);

(ii) Identifying evidence needed in drawing a scientific conclusion (e.g., identifying which variables should be manipulated or controlled);

(iii) Drawing or evaluating conclusions (e.g., giving reasons for or against conclusions in terms of the data provided);

(iv) Communicating valid conclusions (e.g., the production of an argument based on the data given, or on relevant additional information);

(v) Demonstrating understanding of scientific concepts (e.g., making predictions as to the effect of given changes, or identifying factors that influence a given outcome).

Science Themes

PISA identifies 12 broad scientific themes that are deemed to be (a) relevant to everyday situations; (b) of enduring relevance to life in the next decade and beyond; (c) relevant to the assessment of scientific literacy; and (d) capable of being combined with selected scientific processes. The following are the 12 themes, along with examples:

- (i) Atmospheric change (radiation, transmission, pressure);
- (ii) Biodiversity (species, gene pool, evolution);
- (iii) Chemical and physical changes (states of matter, rates of reaction, decomposition);
- (iv) The Earth and its place in the universe (solar system, diurnal and seasonal changes);
- (v) Ecosystems (food chains, sustainability);
- (vi) Energy transformations (energy conservation, energy degradation, photosynthesis);
- (vii) Form and function (cell, skeleton, adaptation);
- (viii) Genetic control (dominance, inheritance);
- (ix) Geological change (continental drift, weathering);
- (x) Human biology (health, hygiene, nutrition);
- (xi) Physiological change (hormones, electrolysis, neurons);
- (xii) Structure and properties of matter (thermal and electrical conductivity).

It must be pointed out, however, that only certain aspects of each theme were assessed in PISA 2000.

Science Areas

Scientific knowledge and concepts in PISA were grouped by area of science. Three broad areas are identified:

- (i) Science in Earth and the environment (e.g., pollution, production and loss of soil, weather and climate);
- (ii) Science in life and health (e.g., health, disease and nutrition, maintenance of and sustainable use of species, interdependence of physical/biological systems);
- (iii) Science in technology (e.g., biotechnology, use of materials and waste disposal, use of energy, transportation).

Science Contexts

As with reading literacy and mathematical literacy, situations or contexts in which science tasks occur were identified, with a view to ensuring a reasonable spread of items across contexts. Four contexts (along with examples) are identified: global (global warming, diminution of biodiversity), historical (advances in scientific knowledge), personal (food and energy use), and public (treatment of water supply).

These dimensions are brought together in a set of 13 science units that include 35 test items. Almost 43% of the items assess students' ability to demonstrate understanding when confronted with scientific material, while 20.0% assess ability to draw and/or evaluate conclusions (Table 1.3). The science themes that are assessed using the largest percentages of items are structure of matter (17.1%), Earth and universe (14.3%), atmospheric change (14.3%) and energy transfer (11.4%). Relatively little attention is allocated to chemical and physical change. Items are distributed over the three science areas: Earth and environment (37.1%), life and health (37.1%) and technology (25.7%). More items are set in a global context (i.e., are concerned with global issues) than in historical, personal or public contexts.

Table 1.3. Distribution of Scientific Literacy Items by Dimensions of the Scientific Literacy Framework

Dimension	*Number of Items*	*Percent of Items*	*Dimension*	*Number of Items*	*Percent of Items*
Science Processes			***Science Themes***		
Communicating conclusions	3	8.6	Atmospheric change	5	14.3
Demonstrating understanding	15	42.9	Biodiversity	1	2.9
Drawing/evaluating conclusions	7	20.0	Chem/Phys change	1	2.9
Identifying evidence/data	5	14.3	Earth and universe	5	14.3
Recognising questions	5	14.3	Ecosystems	3	8.6
			Energy transfer	4	11.4
Science Areas			Form and function	3	8.6
Earth/environment	13	37.1	Genetic control	2	5.7
Life and health	13	37.1	Geological change	1	2.9
Technology	9	25.7	Human biology	3	8.6
			Physiological change	1	2.9
Science Contexts			Structure of matter	6	17.1
Global	16	45.7			
Historical	4	11.4	***Total***	35	100.0
Personal	8	22.9			
Public	7	20.0			

Readability of PISA Texts

An analysis of the readability of materials used to assess literacy in PISA was conducted in Ireland. The analysis, which is reported in Appendix 1, revealed that the English versions of the texts and items used to assess reading literacy are at an appropriate average level of difficulty for students in 9th grade (third year), while those that were used to assess mathematical literacy are somewhat easier. However, the texts and items used to assess scientific literacy are, on average, more difficult (by about seven-tenths of a U.S. grade level) than those used to assess reading literacy. Furthermore, the assessment of scientific literacy involved fewer very easy texts. No appropriate formula was available to analyse the readability of the Irish language versions of the texts.

THE PISA CONTEXT QUESTIONNAIRES

Information about the backgrounds of students who participated in PISA 2000 and their schools was obtained from the students themselves and from their principal teachers through the administration of Student and School questionnaires. The data were subsequently used to interpret students' performance on the assessments of reading literacy, mathematical literacy and scientific literacy. This section describes the Student and School questionnaires used in PISA.

The PISA questionnaires were set in the broader context of the OECD Education Indicators (OECD-INES) programme and sought to obtain information on the social, cultural, economic and educational factors that influence, or are associated with, student achievement. The specific content of the questionnaires was informed by the policy issues identified by participating countries, such as equity in achievement outcomes, and relationships between spending on education and achievement. In Ireland, there was interest in the relationship between the content of courses taken at Junior Cycle level and performance on PISA, so a short section on this topic was added to the Irish version of the student questionnaire. The PISA Questionnaire Framework provides a conceptual overview of factors associated with achievement. It recognises the antecedents of learning, the contexts in which learning occurs, and the content of learning. These are outlined at four levels: the system, the school, the class, and students (Figure 1.1).

Information relevant to some aspects of the framework was not gathered. Thus, information was not gathered on country features (though information on such factors as gross domestic product and expenditure on education was available from other sources), teacher background, intended schooling outcomes, or the implemented curriculum.

Areas of the framework that were covered in detail in questionnaires include school conditions and processes, student background, and student learning behaviours. Information was also gathered on students' reading habits and attitudes towards reading. Since students in participating schools were often distributed over several classes (the sample design is age- rather than grade-based), and since a student's achievement at age 15 might be differentially affected by several teachers over the years, no information was gathered from students' teachers. However, information on such matters as classroom learning processes, and teachers' expectations for students was gathered in the School and Student questionnaires.

Figure 1.1. PISA Questionnaire Framework

	Antecedents	*Contexts*	*Content*
System	Country features (e.g., GDP, wealth distribution)*	Instructional settings and policies (e.g., school management, teacher qualifications at tertiary level)	Intended schooling outcomes (statements of goals for teaching and learning)
School	Community and school features (e.g., school environments and practices; location, size, structure, management)	School conditions and processes (e.g., school equipment, teacher qualifications, school climate variables)	Implemented curriculum
Class	Teacher background	Class conditions, processes (e.g., climate, use of homework, class size, instruction time)	Implemented curriculum
Student	Student background (e.g., socioeconomic status, parental occupation, wealth, cultural capital, age, gender, school attendance)	Student classroom behaviour (e.g., engagement in work)	Attained schooling outcomes (reading literacy, mathematical literacy, scientific literacy, reading habits)

*System-level information on the antecedents of learning was obtained from sources other than PISA.
Note. Shaded cells indicate aspects of education systems that are addressed in the PISA School and Student questionnaires.

Student Questionnaire

All students who responded to the PISA cognitive assessments were asked to complete the PISA Student questionnaire. The questionnaire sought information about the following:

- Background variables, including the gender of the students, their family structure and socioeconomic status, and the level of their parents' education;
- Home educational climate, including parental engagement, level of home educational resources, and number of books in the home;
- Student as learner, including academic orientation, participation in learning support classes for English, absence from school, homework and study, study of science, current grade level, and level of subjects studied at Junior Cycle;
- Classroom processes, including level of help provided by teachers, and teachers' expectations of students;
- Reading habits and attitudes towards reading, including reading diversity, frequency of borrowing library books, frequency of leisure reading, and attitude to reading.

Information in two areas not covered by the framework – students' learning processes and strategies (cross-curricular competencies) (CCCs) and their familiarity with and frequency of use of information and communication technologies[2] (ICTs) – were also obtained through the inclusion of relevant questions on the Student questionnaire. It is planned to focus on ICTs in greater depth in the 2006 PISA assessment.

School Questionnaire

Principal teachers of participating students were invited to complete the School questionnaire. This was designed to elicit information on:

- School Structure, including management and funding;[3]
- School Climate/Policy, including school autonomy and student behaviour;
- School Resources, including student-teacher ratio, class size, and computer-student ratio.

Additional information on the contextual variables that were used to interpret the performance of Irish students in PISA is provided in Chapters 4 (Correlates of Achievement in PISA) and 5 (Explaining Performance on PISA).

IMPLEMENTATION OF PISA IN IRELAND

This section describes preparation for and implementation of PISA in Ireland, including completion of the field trial in 1999 and the main study in 2000. The study was jointly implemented by the Department of Education and Science and the Educational Research Centre (ERC, Dublin).

Development of Test Materials and Questionnaire Items

Prior to the field trial, participating countries contributed units (texts and questions) in reading literacy, mathematical literacy, and scientific literacy that were consistent with the assessment frameworks, to the international consortium charged with developing the PISA assessment materials. Subject matter specialists in participating countries, including members of Ireland's PISA National Advisory Committee, commented on the appropriateness of the materials for the assessment of 15-year olds in their countries. A large item pool was prepared by the international consortium in preparation for the field trial. A similar procedure was followed in identifying items that were appropriate to include in the questionnaires.

Field Trial

A field trial was conducted in participating countries in 1999. Its purpose was to evaluate the appropriateness of test and questionnaire items, and to assess the feasibility and effectiveness of field operation procedures (e.g., sample design, communication with schools, student exclusions, and administration of the test). A sample of 27 schools and 914 students in the greater Dublin area participated. Following the field trial, students'

[2] Because of time and space constraints, the results of the ICT section of the Student questionnaire are not presented in this report.

[3] Information on other aspects of structure such as school type (secondary, vocational, community/ comprehensive), disadvantaged status and gender composition (boys, girls, mixed) was obtained from the Department of Education and Science's database of second-level schools.

responses to the test questions were scored at the Educational Research Centre using scoring rubrics provided by the international consortium.[4]

It was concluded from the field trial in Ireland that test administration was of a high standard, and that, although marking of student responses was labour intensive, trained markers were able to achieve high degrees of inter-rater reliability. Data entry and data cleaning presented relatively few problems. After a field trial had been completed in each participating country, units and items for inclusion in the main study were selected by international subject expert committees. Such factors as cultural appropriateness and suitability, differential item functioning and the fit of items to a one-parameter Item Response Theory model were taken into account.

Main Study

The PISA main study was conducted in Ireland in March 2000. This section describes the target population and exclusions, the sample design and the administration of PISA.

Target Population

The target population comprised all 15-year old students (those born between January 1 and December 31, 1984) who were in full-time education[5] (School-going N = 63,572). This covered 97.3% of 15-year olds in Ireland (2.7% were not at school). The defined target population consisted of students in 'ordinary' (i.e., mainstream second-level) schools in which teaching staff salaries are paid by the Department of Education and Science. The following students were excluded: 722 15-year olds enrolled in special schools (which are classified as primary schools), 76 students in 35 private schools, and 223 students in 24 second-level schools with fewer than 17 students aged 15 enrolled. After these exclusions, the sampling frame of 720 schools included 98.4% of the total 15-year old school-going population and approximately 95.7% of the total number of 15-year olds in the country.

Sampling

A two-stage stratified sample design was used. In the first stage, schools in the sampling frame were stratified according to the total number of 15-year olds in the school in the following manner:

- Stratum 1: Small schools – 17-40 15-year olds (105 schools);
- Stratum 2: Medium schools – 41-80 15-year olds (249 schools); and
- Stratum 3: Large schools – 81 or more 15-year olds (366 schools).

Then, within strata, schools were ordered by school type (secondary, community/comprehensive and vocational) and by gender composition (all boys, all girls, and mixed). To achieve a sample size of 5,250 students, as recommended by the international consortium, and in line with a decision to assess approximately 29 students in each small school, and 35 in each medium and large school, 155 schools were selected to participate – 9 small, 37 medium and 109 large.[6] As one of these selected schools had amalgamated with another school, the actual number of selected schools was 154. Of

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[4] A detailed account of the development of the PISA tests, the implementation of PISA in participating countries, and the scaling of achievement and questionnaire data is to be made available in the form of a Technical Manual on the international PISA website (www.pisa.oced.org) in 2002.

[5] Figure taken from Table 1.2 in the 1996/97 *Statistical Report* of the Department of Education. Dublin: Stationery Office.

[6] Within strata, which had been ordered by school type and gender composition, schools were selected with probability proportional to size.

these, 136 agreed to participate, giving an unweighted response rate of 88.3%. Three replacement schools also agreed to participate, bringing the unweighted school level response rate after replacement to 90.3%. The corresponding weighted response rates were 85.6% and 87.5% respectively.

In the second stage of sampling, the required number of 15-year old students within each participating school was selected at random. Among selected students, functionally disabled students, students with general learning disabilities, students with specific learning disabilities, and those with limited proficiency in the domain being assessed (English) were excluded from the assessment. After refusals, absences, and transfer of students to other schools were taken into account, 3,854 students participated in PISA, yielding a weighted response rate of 85.6%.

Of the 139 schools that agreed to participate, one was located in a Gaeltacht area. Test administration materials, questionnaires, and the tests of mathematical literacy and scientific literacy were translated into Irish to provide students with the option of responding in either English or Irish.

Administration of Assessments

The PISA assessment was administered to selected students in their own schools by inspectors of the Department of Education and Science. Testing took place within a two-week period in March 2000. The use of a rotated test design meant that each student was asked to attempt just a portion of the full pool of assessment units and items. Of the nine test booklets used, five included some mathematical literacy items, five included some scientific literacy items, while all nine included at least some reading literacy items. Testing time was 120 minutes for the cognitive tests. Up to 40 minutes was available for the completion by students of the Student questionnaire.

Senior inspectors monitored the testing sessions in 21 of the schools, and reported directly to the PISA consortium on matters such as the suitability of conditions in which the assessment was carried out, the timing of assessment sessions, and whether or not major disruptions occurred during the sessions.

Following the assessments, students' responses were scored at the Educational Research Centre by trained markers, using detailed marking guides provided by the PISA consortium. As was the case in other countries, it was a requirement that a subset of test booklets be marked four times. In a homogeneity analysis of multiple-marked booklets, an average agreement index of .92 was obtained. This means that 92% of the variance in marks assigned was due to differences between students, and 8% of the variance was due to differences between markers and as such, is regarded as error variance. The agreement index for Irish markers was .93 (international range = .80 to .97), indicating a satisfactory level of agreement between markers in Ireland. It should be pointed out that the error associated with marking student responses is a small fraction of the error associated with the sample design.

ANALYSIS OF PISA DATA

This section summarises the procedures used to scale achievement data, and to conduct the analyses reported in Chapters 3 to 6 of this report.

Scaling of Achievement Data

Student achievement was scaled using Item Response Theory (IRT), which provides an efficient way of summarising data, when a rotated test design is used. IRT places item difficulty and student ability on the same metric so that student ability at a specific level can be described in terms of task characteristics of items associated with that level. While the difficulty levels of items were known, student ability was imputed or inferred, since each student had taken only a portion of the assessment tasks. There are several ways of imputing student ability. In the present study, student ability was imputed by choosing a selection of likely achievement scores, called plausible values, for each student and each domain, as was done for the Third International Mathematics and Science Study (TIMSS)(see Adams, Wu, & Macaskill, 1997). Such values are drawn at random from the distribution of scale scores that could be reasonably assigned to each individual (see Mislevy, 1991). Plausible values contain random error variance components and are not optimal as scores for individuals. However, analyses that combine all plausible values can be used to describe the performance of groups of students. On PISA, five plausible values were assigned to each student for each overall scale (combined reading literacy, mathematical literacy and scientific literacy) and for each of the three reading subscales.

Plausible values were produced from country-by-country regressions, based on principal components analyses of dummy coded Student questionnaire variables and student gender, student socioeconomic status, and the achievement of the school attended by the student, as represented by its percent correct score. As the explained variance associated with the regression of principal components (derived from student contextual variables) on achievement increases, the spread of the achievement distribution from which plausible values are drawn decreases, and thus the measurement error decreases. This procedure is referred to as conditioning.

All of the estimates of student achievement in this report, including mean achievement, achievement at specific percentile points, and percentages of students at various proficiency levels, were derived by weighting and averaging of plausible values, taking both between- and within-imputation variance into account in the estimation of standard errors. Insets 4.2, 4.3, and 4.4, and Appendix 4 provide additional information on the procedures used in analyses reported in Chapters 4 and 6. Insets 6.1 and 6.2, and Appendix 6 provide additional information on the procedures used in Chapter 6.

Estimating Variance Associated with Mean Achievement Scores

The standard errors associated with mean achievement scores reported in Chapters 4 and 5 were computed in a way that took into account the complex, two-stage, stratified sample design. The software used was WesVar 4.0 (Westat, 2000), which incorporates sampling error into estimates of standard errors by a technique known as variance estimation replication. This technique involves repeatedly calculating estimates for N subgroups of the sample and then computing the variance among these replicate estimates. The particular method of variance estimation used was Fay's Balanced Repeated Replication (BRR) method. BRR is generally used with multistage stratified sample designs, and usually has two units (in this case, schools) in each variance stratum. Using Fay's method, half of the sample is weighted by a factor, K (which must be between

0 and 1; for analyses of PISA data, the factor K was set at 0.5), and the other half is weighted by (2 – K). WesVar incorporates the measurement error associated with plausible values when computing mean achievement scores, but does not do so when computing regression coefficients or scores associated with quantiles. The measurement error associated with these was calculated using other procedures, which are described in Appendix 4 (section A4.3).

Conducting Multilevel Explanatory Analyses

A limitation of the correlation coefficients that describe associations between pairs of explanatory and outcome variables is that they do not take the inter-relatedness of explanatory variables into account. In Chapter 5, some explanatory models of student achievement are presented. The analyses underlying these models were carried out using a statistical technique that allows the modelling of multiple variables simultaneously at both the school and student levels (hierarchical linear modelling). The technique is described further in Chapter 5.

2

Achievement Outcomes and Correlates of Achievement in Previous International Assessments

The purpose of this chapter is to establish a context for considering the outcomes of the PISA assessment. First, the findings of earlier international assessments of reading, mathematics and science in which Irish students participated are described. Second, findings from the earlier studies that describe associations between achievement and a range of student- and school-level variables are considered. These include student gender; the home, personal and social backgrounds of students; school characteristics (such as size and gender composition); and school resources. Relationships between classroom variables (e.g., teaching methods and activities) and achievement are not considered, as information on these variables was not obtained in PISA.

ACHIEVEMENT OUTCOMES

Assessments of Reading Literacy

Apart from PISA, Ireland has participated in two international assessments of reading literacy since 1990: the International Association for the Evaluation of Educational Achievement (IEA) Reading Literacy Study (IEA/RLS) in 1991, which involved 9- and 14-year olds, and the International Adult Literacy Survey (IALS) in 1994, which involved adults between 16 and 65 years (Table 2.1). Both studies were carried out in Ireland by the Educational Research Centre.

Table 2.1. International Assessments of Reading Literacy Involving Ireland (1990-2000)

*Year**	*Study*	*Areas Assessed*	*Population(s)*
1991	IEA Reading Literacy Study	Comprehension of Narrative, Expository Texts and Documents	9- and 14-year olds
1994	International Adult Literacy Survey	Prose, Quantitative and Document Literacy	Adults 16-65 years
2000	Programme for International Student Assessment (PISA)	Reading Literacy	15-year olds

*Indicates year in which data were gathered in Ireland.

The IEA Reading Literacy Study (IEA/RLS)

The IEA Reading Literacy Study assessed the performance of students in 32 countries (27 at 9 years of age and 31 at 14 years of age). Literacy was defined as the ‘ability to understand and use those written language forms that are required by society and/or valued by the individual’ (Elley, 1992, p 3). It was assessed using three types of text: *narrative prose* (continuous text in which the writer’s main aim is to tell a story, whether fact or fiction); *expository prose* (continuous text designed to describe or explain factual information or opinion); and *documents* (structured information displays presented in the form of charts, tables, maps or notices).

Inset 2.1. Interpreting the Outcomes of International Studies

Particular care should be exercised in interpreting the outcomes of international studies of educational achievement. A country's rank order is a crude measure of performance, and tells little about such matters as (i) whether the performance of a country is significantly different from that of another country or from the international average; (ii) how achievement is distributed within a country (e.g., what proportions of students or adults have high and low literacy levels); and (iii) what factors account for reported patterns of achievement. All of these issues should be addressed in considering the outcomes of international studies.

The findings of the IEA/RLS have been reported in several publications (e.g., Elley, 1992, 1994; Martin & Morgan, 1994; OECD, 1995). They indicate that Irish 9-year olds (all in third class, primary level) achieved a mean score that was not significantly different from the mean scores of the international and OECD median countries (12th out of 27 countries, and 10th out of 19 OECD countries). In country rankings in each of the three text types, Irish students performed best on reading narrative texts, next best on expository texts, and poorest on documents (Martin & Morgan, 1994). The performance of Irish 14-year olds (who were mainly in second year, second level) was weaker than that of 9-year olds on the test as a whole (20th out of all 31 countries and 16th out of the 19 OECD countries) (Martin & Morgan, 1994; OECD, 1993, Table R1(A) p. 153) However, the performance of Irish 14-year olds was not significantly different the performance of students in the OECD countries ranked 8th to 17th (OECD, 1993). Irish 14-year olds performed at about the same level on the narrative, expository and document scales.

An examination of the distribution of students' scores reveals that Ireland tended to have relatively more high achievers and relatively more low achievers than other countries (Kellaghan, in press; OECD, 1993; Table R1 (B), p. 155). Among 18 OECD countries, Ireland had the second largest percentage of students (3.8) at age 14 scoring two standard deviations or more below the overall country mean.[7] At the other extreme, 2% of Irish students had a score of two standard deviations above the mean. Just seven countries had higher percentages.

The International Adult Literacy Survey – Prose and Documents Literacy

The International Adult Literacy Survey (IALS) was initiated by Statistics Canada and the Educational Testing Service (ETS) in the US and later involved the OECD. Its purpose was to examine levels of literacy in representative samples of 16- to 65-year olds in 24 countries or regions.[8] The assessments were carried out between 1994 and 1998 (10 countries/regions including Ireland participated in 1994; 5 in 1996; and 9 in 1998; OECD/Statistics Canada, 2000). In the study, literacy was defined as 'the ability to understand and employ information in daily activities, at home, at work, and in the community – to achieve one's goals, and to develop one's knowledge and potential' (OECD/Statistics Canada, 2000, p. x). This represents a more functional definition of literacy than that implied by the IEA/RLS definition, and reflects a need to assess 'real-life' literacy skills, as opposed to those typically assessed in school settings. IALS considered literacy to consist of three domains: *prose literacy* (which combines the narrative and expository domains in IEA/RLS), *document literacy* (as in IEA/RLS), and the domain of *quantitative literacy,* defined as the

[7] This point corresponds to the fifth percentile on the achievement distribution (assuming a Normal distribution).

[8] Belgium (Flemish), Belgium (French), Switzerland (French), Switzerland (German) and Switzerland (Italian) were treated as separate regions (populations). Two non-OECD countries, Chile and Slovenia, participated, and the performance of respondents in these countries was taken into account in computing country average scores. Results were not published for France or Northern Ireland.

knowledge and skills required to apply simple arithmetic operations, either alone or sequentially, to numbers embedded in printed materials, such as balancing a chequebook, figuring out a tip, or completing an order form.

All items in IALS were open-ended in an effort to establish the authenticity of the assessment tasks. Within each domain, a range of skills was assessed, including locating, integrating and generating information. The tasks were administered to nationally representative samples of adults, usually in their own homes. Information was also obtained on a range of factors that might help explain respondents' levels of literacy proficiency (Morgan, Hickey & Kellaghan, 1997; OECD/HRDC, 1997; OECD/Statistics Canada, 2000).

Mean scores achieved by participants in IALS were reported for each country. In addition achievement was reported by proficiency level.[9] The levels were determined following a consideration of technical properties of the scales, and the skills and processes represented by the items at different scale points. Each level represents an interval or space along a continuum of achievement. For example, proficiency Level 1 on the Prose scale describes relatively simple literacy tasks such as 'locating one piece of information in the text that is identical to or synonymous with the information given in the question' (OECD/Statistics Canada, 2000, p. 95). Proficiency Level 3 describes a more complex set of processes in that the reader at that level can 'integrate or compare and contrast information across paragraphs and sections of text ' (p. 98).

On the IALS Prose scale, the overall Irish mean of 265.7 (SE = 3.3) ranked 14th out of 22 countries/regions (OECD/Statistics Canada, 2000). Irish adults performed significantly less well than adults in ten countries/regions, significantly better than adults in five, and at about the same level as adults in six. Almost one quarter (22.6%) of Irish adults scored at Level I, 30.0% at Level 2, 34.1% at Level 3, and 13.5% at Levels 4/5. Level 1 scores were more common among older (56-65 years old) respondents, of whom 39.9% scored at this level, than among younger (16-25 year old) respondents (15.9%).

Percentages of Irish respondents at each level of the Documents scale were broadly similar to those for the Prose scale, with Ireland ranking 17th of 22 countries. The performance of Irish adults on the Quantitative scale is discussed in a later section of this chapter.

The relatively large proportion of Irish adults scoring at Level 1 on the IALS prose proficiency scale has attracted much attention, which has served to focus attention on how levels were established. Kellaghan (in press) has drawn attention to the arbitrariness of the scales, pointing out that, if one lowered the cut point for Level 1 from 225 to 200, the percentage of Irish adults at that level would drop from 23 to 12. Likewise, altering the response probability (the probability of responding correctly to the easiest items at a level), which was .80 in IALS, but is as low as .50 in other studies, would have resulted in quite different proportions of individuals being assigned to the levels. Murray (2000) has commented that cut points were derived from US data and may not be equally appropriate for all countries or groups within countries. It is not without interest that 75% of French adults (compared to 52% of Irish adults) were found to be at Level I or 2 of the Prose scale, prompting France not to publish its results (Blum & Guérin-Pace, 2000).

Assessments of Mathematics

Since 1990 and prior to PISA, Ireland has participated in two international assessments of mathematics (and science) involving school-based populations: the Second International Assessment of Educational Progress (IAEP II) in 1991, which involved 9- and 13-year olds, and the Third International Mathematics and Science Study (TIMSS) in 1995,

[9] Each IALS domain is represented by a scale that ranges from 0-500, with a mean of 250, and a standard deviation of 50. The cut points for proficiency levels are: Level 1: 0-225; Level 2: 226-275; Level 3: 276-325; Level 4: 326-375; and Level 5: 376-500. In reporting results, proficiency Levels 4 and 5 (the highest levels) were combined as, in most countries, there were few individuals at Level 5.

which involved pupils in third and fourth classes in primary schools and in first and second years in second-level schools. In Ireland, both studies were carried out by the Educational Research Centre. As indicated above, a measure of the 'quantitative literacy' of Irish adults was obtained in the International Adult Literacy Survey.

Table 2.2 International Assessments of Mathematics and Science Involving Ireland (1990-2000)

Year	*Study*	*Areas Assessed*	*Population(s)*
1991	IAEP II	Mathematics, Science	9- and 13-year olds
1994	International Adult Literacy Survey	Literacy, including Quantitative Literacy	Adults 16-65 years
1995	Third International Mathematics and Science Study (TIMSS)	Mathematics, Science	3rd/4th classes (primary level) 1st/2nd years (second level)
2000	Programme for International Student Assessment (PISA)	Mathematical Literacy, Scientific Literacy (also Reading Literacy)	15-year olds

IAEP II Mathematics

The assessment framework at both age levels in IAEP II mathematics included five mathematical content areas (Numbers and Operations; Measurement; Geometry; Data Analysis, Statistics and Probability; and Algebra and Functions), and three cognitive processes (Conceptual Understanding; Procedural Knowledge; and Problem Solving) (Lapointe, Mead, & Askew, 1992). The assessment instrument at both levels consisted of multiple-choice and short-answer items.

At age 9, Ireland ranked 7th of 10 countries on overall achievement (percentage of items correctly answered). Five countries achieved significantly higher mean scores than Ireland, three achieved mean scores that are not significantly different, and one achieved a significantly lower mean score (Martin, Hickey, & Murchan, 1992). At age 13, Ireland ranked 11th of 15 countries. Five countries achieved mean scores that are significantly higher, seven mean scores that are not significantly different, and three scores that are significantly lower.

Irish 9-year olds achieved mean scores that do not differ significantly from the international country averages in three content areas (Number and Operations, Data Analysis, Statistics and Probability, and Algebra and Functions). In two other areas (Measurement and Geometry), they scored significantly below the international averages. At age 13, Irish students scored significantly higher than the international average on Numbers and Operations, and at about the same level in other content areas.

In an analysis of the distribution of achievement scores on IAEP II Mathematics at age 13 in 10 OECD countries, 15% of Irish students scored in the 'below average range' (i.e., one standard deviation below the international mean) (OECD, 1993). Only three countries had a greater proportion of students in this category. In one country, only 5.7% of students had such low scores.

TIMSS Mathematics

The target populations in the Third International Mathematics and Science Study (TIMSS) were the two adjacent class levels in which the majority of 9- and 13-year olds were enrolled. In Ireland, these were third and fourth classes in primary schools and first and second years in second-level schools. The assessment instruments consisted of multiple-choice (75%) and short-answer (25%) questions.

The assessment framework at the third and fourth class levels comprised six mathematical content areas: Whole Numbers; Fractions and Proportionality; Measurement, Estimation and Number Sense; Data Representation, Analysis and Probability; and Patterns, Relations and Functions. At first and second year levels, the content areas were: Fractions and Number Sense; Geometry; Algebra; Data Representation, Analysis and Probability; Measurement; and Proportionality. The present review deals with student performance at the fourth class and second year levels.

The average scale score of Irish students in fourth class was 550 (SE = 3.4), which was significantly higher than the overall mean of students in 17 participating OECD countries (537). This score gave Irish students a rank of 6th[10] (OECD, 1997). Irish students performed at about the same level as students in four countries, significantly better than students in eight countries, and significantly less well than students in four countries (OECD, 1997, Chart F1.1). Irish students in second year achieved a mean score of 527 (SE = 5.1), which did not differ significantly from the OECD country mean of 526.[11] Ireland ranked 8th among 17 participating countries (OECD, 1997, F1.3).

Relative to their performance on the assessment as a whole, Irish fourth class students performed better in one content area (Fractions and Proportionality), less well in one area (Measurement), and at the same level in other areas. The performance of students in second year was significantly higher than on the test as a whole in three content areas (Fractions and Number Sense, Data Representation, Analysis and Probability, and Proportionality), and significantly lower in two areas (Geometry and Algebra). Performance in one area (Measurement) was at about the same level as on the test as a whole.

International Adult Literacy Survey – Quantitative Literacy

As noted above, Irish adults (16-65 years) in the International Adult Literacy Survey (IALS) were assessed on quantitative literacy. Among the tasks that participants were asked to perform were: read a graph and compute percentages, compare and use information from two graphs, use a table to determine the compound interest payable on an investment at a specified interest rate and for a specified period of time. On a Quantitative scale that was constructed for the survey, 25.0% of Irish adults scored at proficiency Level 1, 28.3% at Level 2, 30.7% at Level 3 (the level considered a suitable minimum for coping with the demands of everyday life and work in a complex, advanced society), and 16.2% at Levels 4/5. Ireland ranked 18th of 22 countries/regions on this measure (OECD/Statistics Canada, 2000). Its mean score of 264.6 (SE = 3.2) was at the same level as the mean of respondents in one country, below the mean of 16 countries, and above the mean of four countries.

Assessment of Science

Since 1990 and prior to PISA, Ireland has participated in two international studies that involved the assessment of science: the Second International Assessment of Educational Progress (IEAP II), which was conducted in 1991, and involved 9- and 13-year olds, and the Third International Mathematics and Science Study (TIMSS), which was conducted in 1995, and involved students in third and fourth classes in primary schools and in first and second years in second-level schools (see Table 2.2).

IAEP II Science

At both ages, the assessment framework for IAEP II comprised four science content areas (Life Sciences, Physical Sciences, Earth and Space Sciences, and Nature of Science) and three science processes (Knows Science, Uses Sciences, and Integrates Science). The performance of Irish students was poor. At age 9, it ranked last of 10 countries. Irish

[10] England and Scotland were treated as separate countries in TIMSS.
[11] When all participating countries in TIMSS are considered, Irish students in second year achieved a score that was significantly higher than the international mean (Beaton et al., 1996a).

students' mean score (percent correct) was significantly below the international mean (Martin et al., 1992). Irish 13-year olds ranked 14th of 15 countries, and achieved a mean score that was also significantly below the international average. When comparisons are confined to OECD countries, Irish 13-year olds ranked 9th of 10 countries (OECD, 1993).

Irish 9-year olds achieved a mean score that does not differ significantly from the international average in one content area (Earth and Space Science). Performance was significantly below the international average in the three other areas in the assessment. It was also below the international average on the three science processes. Irish 13-year olds achieved mean scores that are not significantly different from the international average in two content areas (Nature of Science and Earth and Space Sciences), and are below the international average in two other areas. Their scores do not differ significantly from the international average on the three science processes.

TIMSS Science

In TIMSS, students at primary level (third and fourth classes) were assessed on their knowledge of science in four content areas, while first and second year students in second-level schools were assessed in five areas. The assessments consisted of multiple-choice (75%) and constructed response (25%) items. In this section, the performances of fourth class students in primary schools and second year students in second-level schools are considered.

Irish fourth class students ranked 10th among students in 17 OECD countries, achieving a mean score (539) that was not significantly different from the OECD country average (543) (OECD, 1997, Chart F1.4). They performed at about the same level as students in six countries, significantly better than students in three countries, and significantly less well than students in seven countries (OECD, 1997, Chart F1.2). Irish students in second year ranked 9th of 17 OECD countries, achieving a mean score (538) that is not significantly different from the OECD average (537) (OECD, 1997, Chart F1.4).

Irish students in fourth class performed better than on the test as a whole in one science content area (Life Science), at about the same level in one area (Earth Science), and less well in two (Environmental Issues and the Nature of Science, and Physical Science) (Martin et al., 1997). Irish students in second year performed at about the same level as on the test as a whole on three content areas (Earth Science, Life Science, and Environmental Issues and the Nature of Science), and significantly less well in two (Physics and Chemistry) (Beaton et al., 1996b).

CORRELATES OF ACHIEVEMENT

In this section, a range of variables associated with achievement in international studies are examined, including those between student achievement and gender; between student achievement and the home, personal and social backgrounds of students; and between aggregated student performance in a school (average school-level achievement) and school size and resources.

Gender Differences in Achievement

In this subsection, gender differences in reading literacy, mathematics and science are described.

Gender Differences in Reading Literacy

Gender differences were identified in the two international studies of reading literacy, one at the school level [IEA Reading Literacy Study (IEA/RLS)] and one at the adult level

[International Adult Literacy Survey (IALS)]. In IEA/RLS, females achieved significantly higher mean scores than males in 19 of 27 countries at age 9, and in 13 of 31 countries at age 14 (Martin & Morgan, 1994). Ireland had the seventh largest difference at age 9 (20 points or one fifth of a standard deviation on the international scale), and the third largest at age 14 (23 points, or just under one quarter of a standard deviation).

Gender differences were also observed for three text types. Irish female students achieved significantly higher mean scores than male students on the Narrative and Expository scales at age 9, and on Narrative, Expository and Documents scales at age 14 (Wagemaker, 1996). The magnitude of the differences varied with text type and age. Whereas the differences on Narrative texts at ages 9 and 14 were of similar size (20 and 19 points respectively), the differences on Expository texts were not (22 at age 9, and 40 at age 14). The magnitude of the gender difference in Ireland among participating countries ranked 10th for Narrative, 6th for Expository and 16th for Documents at age 9. At age 14, the corresponding ranks were 1st, 3rd, and 5th.

Analysis of the distribution of overall achievement scores in IEA/RLS revealed that Ireland had the second highest mean gender difference among students scoring in the lowest quartile[12] at age 9, and the highest at age 14 (Martin, 1996). In contrast, differences between males and females in the top quartile were small for both age groups. In an earlier report, it had been estimated that, at age 14, twice as many males as females in Ireland had overall reading scores that were two or more standard deviations below the mean (Martin & Morgan, 1994).

Gender differences were also observed among adults on the IALS Prose and Documents scales. Males were more strongly represented at the lowest reading proficiency level (Level 1) on both scales, and at the highest proficiency level on the Documents scale (Morgan et al., 1997). Compared to other countries that participated in the first phase of IALS, gender differences in Ireland were small, but somewhat greater than in other countries (Morgan et el., 1997).

Gender Differences in Mathematics

Differences in the performance of males and females were observed in some studies of mathematical achievement, but not in others. Moreover, where significant differences were observed, they tended to be smaller than those reported for reading literacy. In the International Assessment of Educational Progress (IAEP II) study, differences between Irish male and female students at age 9 were not significant on the overall test or in individual content areas (Martin, Hickey, & Murchan, 1992). Indeed, significant differences in overall achievement were found in only three countries (Korea, Italy and Israel) out of 10 with comprehensive populations. At age 13, in Ireland, male students achieved a mean score on the overall test that was significantly higher (by 5 percentage points) than the score of female students (Martin et al., 1992). In all, significant differences were also found for six countries out of 15 with comprehensive populations. In Ireland, male students outperformed female students in three mathematical content areas (Measurement, Geometry, and Algebra and Functions), while differences were not significant in two other areas (Numbers and Operations, and Data Analysis, Statistics and Probability). Male students outperformed female students on items involving two cognitive processes (Conceptual Understanding and Problem Solving), but not on items which assessed Procedural Knowledge.

[12] Students in the lowest quartile are students whose scores are in the bottom 25% of a distribution of scores (i.e., below the 25th percentile), while students in the top quartile are those with scores in the top 25% (i.e., above the 75th percentile).

In a further major international study of mathematical achievement (TIMSS), gender differences in overall achievement or in individual content areas were not significant for students in fourth class in primary schools, or in second year in second-level schools (Beaton et al., 1996a; Mullis et al., 1997).[13]

Examination of performance in the upper and lower quartiles on the TIMSS mathematics scales revealed roughly equal proportions of Irish male and female students at both grade levels in both quartiles (Mullis et al., 2000). This contrasts with the situation in reading literacy where there were pronounced gender differences favouring females in the lower quartile (Martin, 1996).

In IALS (16-65-year olds), almost 6% more Irish males than females scored at the highest level of proficiency (Levels 4/5) on the Quantitative literacy scale, while almost 6% more females than males scored at the lowest level (Morgan et al., 1997). Gender differences were more pronounced on the Quantitative scale than on the Prose or Documents scales, and tended to be larger than in other countries that participated in the first phase of the study.

Gender Differences in Science

Gender differences in overall achievement in science favoured of Irish male students in IAEP II (at ages 9 and 13), and in TIMSS (in second year, but not in fourth class). In IAEP II, at age 9, the mean score of male students was 3 percentage points higher than the mean score of female students, and was the second largest difference among 10 countries with comprehensive populations, while at age 13, male students on average outperformed female students by 5 points, the second highest among 15 participating countries (Lapointe et al., 1992). At age 9, in Ireland, male students achieved significantly higher scores than female students in two science content areas (Physical Sciences and Earth and Space Sciences), and at about the same level in two others (Life Sciences and Nature of Science). At age 13, Irish male students achieved higher mean scores in three areas, but not in Nature of Science.

In a comparison of gender differences in science achievement in OECD countries that participated in TIMSS, Irish male and female students in fourth class performed at about the same level on the overall scale, although in 9 of 17 countries significant differences were found in favour of male students (OECD, 1997). At second year level in Ireland, male students performed significantly better than female students (OECD, 1996). The size of the difference (13 score points), was two thirds of the OECD country mean gender difference, and ranked Ireland 10th of 24 OECD countries in terms of gender difference in performance.

Irish male students, on average, performed significantly better than female students in one TIMSS science content area at the fourth class level (Earth Science), and in one at second year (Physics) (Beaton et al., 1996b; Martin et al., 1997).

An examination of the representation of male and female students in second year in the upper and lower quartiles on the TIMSS science scale did not reveal a difference that was statistically significant at either grade level (Mullis et al., 2000).

Student Home, Personal and Social Background Variables and Achievement

This subsection is divided into six parts. In the first four, associations between student social and home background variables and achievement are considered. In the fifth, associations between students' attitudes towards subjects and their achievement in those

[13] OECD (1996, Table R10) reported a significant difference in favour of Irish male students in eighth grade (second year) in TIMSS. However, the size of the standard error of the difference in the OECD comparison is incorrect, and therefore the difference is actually non-significant.

subjects are described. In the sixth, links between students' perceptions of a subject (science) and their achievement in that subject are considered.

Parents' Educational Attainment

The educational attainment, occupational status, and income level of a student's parents may be taken as proxies for socioeconomic status. In most countries that participated in TIMSS, parents' highest level of education was associated with the achievement of second year students in mathematics and science (Beaton et al., 1996a, 1996b). In Ireland, students in families in which at least one parent had completed a university degree (17%) achieved a mean score that was one half of a standard deviation higher than the mean score of students in families in which the parent with the highest educational attainment had completed primary, but not upper secondary, education (26%).

Home Educational Environment

One measure of the educational environment of the home that has been consistently found to be associated with student achievement is the number of books in a student's home. In IEA/RLS, a steady increase in the reading literacy scores of 9- and 14-year olds was observed across most countries as the number of books in their homes increased (up to about 200 books) (Elley, 1992). In TIMSS, Irish students in second year who lived in homes with between 100 and 200 books achieved a mean score in mathematics that was 59 points (three-fifths of a standard deviation) higher than the mean score of students in homes with between 11 and 25 books.

A related measure, home educational aids (defined as access to a dictionary, study desk/table and computer), was also linked to achievement in mathematics and science in TIMSS. However, while the difference in mean achievement scores between second year students who had access to all three aids, and those who had access to fewer than three was significant, the magnitude of the difference (20 points or one fifth of a standard deviation on the international scale) was small relative to other countries in the study (Beaton et al., 1996a).

Engagement in Learning at Home

In several studies, measures that indicate students' engagement in learning at home have been linked to achievement. In TIMSS, the frequency with which second year students did homework was associated with achievement in mathematics and science in several countries. In Ireland, students who spent 2-3 hours per night at homework/study across all subjects achieved a mean score in mathematics that was almost one-third of a standard deviation higher than that achieved by students who spent between 1-2 hours (Beaton et al., 1996a). However, students who spent more than three hours had a mean score that was not significantly different from that of students who spent between 2-3 hours. A similar association between time spent on homework/study across all subjects and achievement was observed for science, though, in Ireland, the gap in achievement between students who spent 2-3 hours and 1-2 hours on homework/study was smaller than for mathematics.

A related variable, time spent in voluntary reading, was found to be associated with reading achievement in the IEA/RLS. In general, an increase in time engaged in voluntary reading was associated with an increase in reading literacy scores (Elley, 1992). The association was stronger at age 9 than at age 14. Furthermore, in most countries, including Ireland, 14-year olds in the second and third quartiles on the frequency distribution of time spent on voluntary reading achieved higher mean scores in reading literacy than students in the top quartile, suggesting that a large amount of voluntary reading at age 14 is not necessary to sustain the reading skills acquired at a younger age. In IAEP II, frequency of voluntary reading was found to be associated with achievement in mathematics and science in most countries, including Ireland, at age 13 (Martin et al., 1992).

Family Size

Family size (number of siblings) was found to be negatively associated with achievement in mathematics and science for 13-year olds in most countries that participated in IAEP II. However, no association was found for either subject in Ireland (Martin et al., 1992).

Attitudes To Reading, Mathematics and Science

Several studies have examined the association between students' attitude towards a subject and their achievement in that subject. Attitudes to reading are not discussed here since no data on this topic *per se* were collected in IEA/RLS. However, it was found that liking reading was the most popular strategy (of 11) for becoming a good reader, chosen by 69% of 14-year old students. In IAEP II, 90% of Irish 13-year olds said that they had a positive attitude towards mathematics, and 57% a positive attitude towards science (Martin et al., 1992). Furthermore, a positive association between attitude and achievement was found in the case of science. However, the relationship between attitude and achievement in mathematics was not significant, as might be expected since nearly all students indicated that they liked the subject. In TIMSS, 74% of Irish second year students reported either a liking or a strong liking for mathematics. Mean mathematics achievement scores increased in proportion to students' liking for the subject, with 20 score points (a fifth of a standard deviation) separating those who liked mathematics a lot from those who simply liked mathematics (Beaton et al., 1996a). Similar associations were found for most countries, though the proportions indicating a liking/strong liking for mathematics were lower in some high-achieving countries (Japan and Korea) than in Ireland. In the same study, 67% of Irish second year students said that they either liked science, or liked it a lot (Beaton et al., 1996b). However, no evidence of a direct association with achievement was revealed.

Perceived Efficacy of Science

Half of Irish second year students in TIMSS indicated agreement or strong agreement with the view that it was necessary to do well in science to get a desired job, while 67% indicated the need to do well in science to get into an upper secondary school or college of their choice (Beaton et al., 1996b). These percentages were low compared to those in other participating countries. TIMSS did not describe associations between the perceived need to do well in science and achievement in the subject. However, in a series of hierarchical linear models that were constructed to predict the effectiveness of schools in science, students' belief in the efficacy of science explained a significant amount of the variance in achievement in several TIMSS countries, but not in Ireland (Martin et al., 2000, Exhibit B.9).

Variables Associated with School-level Achievement

This subsection is divided into three parts. In the first, research describing the proportion of variance in school mean achievement that has been found to be attributable to between-school differences is considered. In the second, variables associated with differences in achievement at the school level are considered. In the third, research that has sought to explain between-school variance by considering the simultaneous contributions of both school and student-level variables is examined.

Variation in Student Achievement Between Schools

One strand of research associated with international studies has sought to identify the proportion of variance in achievement that can be attributed to differences between schools within countries. When the proportion of variance that lies between schools is large (and hence, within-school variance is small), schools differ significantly in achievement from one another, while, within schools, students achievements do not vary much. Conversely, if a small proportion of variance lies between schools, then average school achievement is similar from school to school, and variation within schools is correspondingly greater. There are considerable differences between countries in the proportions of achievement that lie between and within schools. In IEA/RLS at age 14, in the Nordic countries and in West Germany, less than 10% of the variance in reading achievement lay between schools. In contrast, the figure for Ireland was 48%, and for Switzerland and the Netherlands, 50% (Postlethwaite, 1995). In TIMSS, between-school variance at second year in second-level schools ranged from 11% to 64% for mathematics, and from 7% to 41% for science (Martin, Mullis, Gregory, Hoyle & Shen, 2000). In Ireland, the figure was 50% for mathematics, and 38% for science. These percentages are high relative to those reported for other countries. [14]

Research in the area of school effectiveness has focused on variables that account for differences between more effective and less effective schools. These variables relate to students' home background circumstances, school characteristics, school management, and school resources.

Home Background Variables

The association between home background variables and average school achievement has been well documented in international studies. In the IEA/RLS, a measure of 'home circumstances', consisting of the number of books in the home, possessions in the home, regularity of meals, and use of the test language in the home was used to predict students' achievement scores at both individual and school levels. For Irish students at age 9, the correlation between a home circumstances composite and achievement was .27 at the individual student level, and .49 at the school level (Postlethwaite & Ross, 1992). Nine of 26 countries had stronger school-level correlations. In TIMSS, a similar composite, consisting of the number of books in the home, presence of study aids, possessions in the home, level of educational attainment of parents, and number of hours spent doing chores at home, explained 51% of between-school variance for Irish second year students in mathematics, and 52% in science (Martin et al., 2000).

School Characteristics

Among the school characteristics that have been associated with high average school achievement in international studies are school size (the number of students enrolled), school type (private or state supported), student-teacher ratio, class size, and the number of serious problems reported by the school principal (e.g., relating to staffing, resources). Across all countries in IEA/RLS, schools with higher than expected average reading scores at age 9 (after taking home background into account) were larger in size (compared to schools with lower than expected scores), were located in urban areas, had larger class sizes, and were private rather than public (Postlethwaite & Ross, 1992). The school characteristics that distinguished more effective from less effective schools for Irish students were school size (larger schools were more effective), a higher reading/learning

[14] Intact classes (one per school) were selected to participate in the IEA/RLS. Hence, between-school differences may be overestimated in countries in which streaming is implemented. The same problem arises in the case of TIMSS mathematics, where single, intact classes were also selected. In TIMSS science, students were selected with reference to the mathematics classes of which they were a part.

support teacher-student ratio, and fewer serious problems (such as staffing and resource shortages).

Across all countries in TIMSS, a range of school characteristics differentiated between high achieving schools (the third of schools with the highest average achievement scores) and low achieving schools (the third with the lowest average scores). Higher-achieving schools were usually located in urban areas and had class sizes that were larger than the country mean. They also reported dealing with fewer incidents of student misbehaviour and student administrative violations (arriving late at school, absenteeism, skipping classes and violating the school dress code) (Martin et al., 2000). However, this pattern was not reflected in Ireland in that only one of these variables, class size, was significant for mathematics only.

School Resources

International studies have documented an association between quantity of school resources and achievement at the school level. Across all countries in IEA/RLS, the most effective schools in reading at age 9 (after adjustments had been made for students' home background) were those with more books in their school libraries, higher numbers of library books per student, a student newspaper, and high levels of school resources (a composite based on whether or not a school had a library, a reading room for students, a student/school newspaper or magazine, and a professional library for teachers) (Postlethwaite & Ross, 1992). Two of these variables, reading materials in the school and school resources, differentiated more effective from less effective schools in Ireland. Direct associations between school resources and average school achievement (in mathematics and science) were not included in reports on IAEP II and TIMSS.

Models of School Effectiveness

Clearly, many of the student and school-level variables that have been found to be associated with achievement do not function independently. For example, schools that have well-stocked libraries may also be large, and may be located in urban areas. Likewise, students of parents with high levels of education may read more frequently and do more homework than students of parents with lower levels. To address this issue, a series of hierarchical linear models was constructed with the TIMSS data for second year in an attempt to identify the proportions of between-school variance that were accounted for by different sets of variables, and those variables that were most strongly associated with school average achievement in mathematics and science at the second year level (Martin et al., 2000).

The most complete model (which included clusters of variables labelled 'classroom characteristics', 'teacher characteristics', 'school climate', 'school size and location', 'home-school interaction', and 'average home background') explained 68% of between-school variance in mathematics achievement. In Ireland, the percentage (80%) was higher. However, a model that included only the average home background at the school level accounted for 43% of between-school variance across countries, and 52% in Ireland. Thus, it would appear that, while home background explains a considerable proportion of between-school variance in mathematics achievement, other variables, including ones relating to the management and organisation of schools also play a role. In addition to home background the variables that had significant associations with school achievement in the full model in Ireland were frequency of doing homework across subjects, class size for mathematics lessons, students' educational aspirations, and their mothers' academic press.

In science, a complete model similar to that constructed for mathematics explained 68% of between-school variance across countries in the analysis, and 72% of between-school variance in Ireland. Again, a model that included only average home background of student variables explained 48% of variance between schools across countries, and 49% of such variance in Ireland. Apart from home background, the variables that were significantly associated with school achievement in the final model for Ireland were frequency of doing homework across subjects, students' attitude to science, and students' educational aspirations.

CONCLUSION

In general, Irish students have performed at about the OECD country average in international studies of educational achievement. In the IEA Reading Literacy Study, Irish 9- and 14-year old students achieved mean scores that were close to those of both the international and OECD median countries. In the Third International Mathematics and Science Study (TIMSS), Irish students in fourth class achieved a mean score in mathematics that was significantly higher than the OECD country average, while students in second year achieved a mean score that was not significantly different. At the same class levels, they achieved mean scores in science that were not significantly different from OECD country averages.

The findings of the International Adult Literacy Survey (IALS) are difficult to interpret. The survey tells us little about any severe literacy problems that may exist in the Irish population since individuals with very poor literacy skills were excluded. Furthermore, the value of the response probability criterion used in assigning individuals to proficiency levels may be regarded as unreasonably high, resulting in relatively large proportions of adults being assigned to the lowest levels of proficiency.

The performance of Irish students in TIMSS science, which was average among participating countries, compared to their poor performance in the earlier IAEP II science study, raises questions about the comparability of international assessments. One or more of a variety of factors may have contributed to the discrepancy in the findings of the two studies: differences in exclusion and participation rates, differences in approaches to data analysis, changes in levels of achievement over time, and differences in measuring instruments (O'Leary, Kellaghan, Madaus & Beaton, 2000).

Such issues point to the need to exercise caution in interpreting and comparing the findings of international studies. However, some consistencies do emerge. For example, some countries in Asia (Korea, Japan, Taiwan) perform consistently above the international average in assessments of mathematics and science, while students in Scandinavian countries (especially Finland) tend to perform well in assessments of reading literacy.

International studies can provide useful information on the performance of students in particular content areas, though it should be noted that definitions of content areas vary across studies. The available evidence suggests that Irish second-level students perform relatively well in the areas of number, fractions and probability, and less well in algebra, geometry, and measurement. The performance of Irish students on probability items is perhaps surprising, given that probability is not on the Junior Cycle syllabus. Comparisons across science content areas are more problematic, given the differences in overall performance of Irish students across studies. However, in TIMSS, Irish students in second year did better in earth and life sciences than in physical sciences (Physics and Chemistry).

Finally, previous international studies point to a relatively high proportion of low achieving students in Ireland with respect to mathematics and reading. In IEA/RLS, Ireland had the second largest percentage of 14-year olds among participating OECD countries that scored two standard deviations below the overall OECD country average. Evidence from IAEP II mathematics at age 13 is similar.

In IEA/RLS, the only international study of reading literacy carried out in schools in which Ireland participated, overall gender differences in favour of female students were larger than in many other countries and increased between primary and second levels. Differences were particularly apparent for Expository and Documents texts at second level. Gender differences in reading literacy among adults appear to be less pronounced, though Irish male adults in the IALS study were more strongly represented than females at the lowest levels of proficiency in Prose and Documents literacy.

In mathematics, the situation is less clear. In IAEP II, no gender differences between Irish male and female students at age 9 were found on the overall test or in individual mathematical content areas. However, a significant difference in favour of male students was observed at age 13 on the overall performance, in three mathematical content areas, and on two mathematical processes. In TIMSS, no significant gender differences were evident on the tests as a whole or in individual content areas among Irish students in fourth class (primary level) or second year (second level).

Differences in favour of male students at ages 9 and 13 in science in IAEP II were among the highest in participating countries. However, the difference in TIMSS, favouring male students at second year in second-level schools, was just two-thirds of the OECD average difference. In both international studies, male students tended to do better than female students in Ireland on questions in the physical sciences and in Earth science, while male and female students performed at about the same level on questions dealing with life sciences.

International studies have also drawn attention to a range of variables other than gender that are associated with achievement at student and school levels. Among the student background variables that have been found to be associated with the achievement of individual students in reading, mathematics and science are parents' educational attainment, number of books in the home, access to educational resources at home, and engagement with learning activities outside school (e.g., frequency of doing homework, and frequency of engaging in voluntary reading).

Another set of variables that may account for differences in achievement between students are their attitudes to reading, mathematics and science. In general, such variables appear to be less useful in explaining variation in achievement than ones that describe home background or engagement in learning.

Some international studies have partitioned achievement into within- and between-school components. In the IEA reading literacy study, 48% of variance in overall reading achievement at age 14 lay between schools, while in TIMSS, at second year level, the figure was 50% for mathematics achievement and 38% for science achievement. These percentages are high relative to those reported for other countries, and serve to highlight differences in achievement between second-level schools in Ireland.

In an effort to explain between-school variance in achievement, a series of hierarchical linear models was constructed using data from TIMSS. The final models, which, for Irish data, explained 80% of between-school variance in mathematics in second year, and 72% in science, were contrasted with models in which only home background had been included, and which accounted for 43% of between-school variance in mathematics and 52% in science. However, while the findings may point to the relative influence of home and non-home factors, they do not provide a comprehensive picture since important variables, such as gender and ones that might be of interest in particular national contexts, were not included in the analyses.

3

The Performance of Irish Students on PISA in an International Context

This chapter reports the performance of Irish students on the PISA assessments of reading literacy, mathematical literacy and scientific literacy. The outcomes for Irish 15-year olds are presented in the context of the performance of students in the same age cohort in other participating OECD countries. First, the achievement outcomes are presented for combined reading literacy, and for three reading literacy subscales. In the second and third sections, achievement outcomes for those aspects of mathematical and scientific literacy that were assessed in PISA are summarised. The chapter concludes with a consideration of the inter-relatedness of scores on the PISA scales and subscales. In Chapter 4, factors associated with achievement, such as gender and socioeconomic status, are described.

The scaling of PISA involved the application of a mixed coefficients multinomial logit model – a generalised form of the Rasch item response theory (IRT) model. Using this approach, common scales were obtained for combined reading literacy, for three reading subscales, and for mathematical and scientific literacy, even though individual students were administered different (though sometimes overlapping) sets of items. Multiple imputation was used to obtain reliable indices of student proficiency, known as plausible values.[15] These plausible values were used to estimate population parameters such as mean reading literacy scores. The PISA achievement scales in combined reading literacy, mathematical literacy and scientific literacy were set to a mean score of 500 and a standard deviation of 100, using random samples of 500 students drawn from each participating OECD country.[16]

ACHIEVEMENT IN READING LITERACY

In this section, the outcomes of the PISA reading literacy assessment are summarised in terms of (i) the overall performance of students; (ii) the proportions of students achieving each of the PISA proficiency levels; and (iii) the scores of students at four key markers (10th, 25th, 75th and 90th percentiles). Throughout the section, reference is made to achievement on the combined reading literacy scale, and to achievement on the three reading literacy subscales – Retrieve, Interpret, and Reflect/Evaluate.

Interpreting Scores on the Reading Literacy Scales

As indicated in Chapter 1, students were assessed on their ability to read texts and respond to comprehension questions based on those texts. The test included a range of continuous and non-continuous texts, including descriptions, narratives, expository texts, charts/graphs, tables, diagrams, maps, forms and advertisement. Questions focused on three reading processes: (i) retrieving information; (ii) developing an interpretation; (iii) reflecting on and evaluating the form and content of the text. Examples of passages and

[15] The plausible values generated for each student are picked at random from an estimated ability distribution of students with similar item response patterns and backgrounds, and are intended to provide good estimates of parameters of student populations (for example, country mean scores), rather than estimates of individual student proficiency. Chapter 1 contains additional information on the scaling of student achievement in PISA.
[16] Due to a low school-level response rate, data from the Netherlands were not included in the scaling process.

items used in the assessment may be found in Appendix 1. For analysis purposes, a scale was developed for combined reading literacy (i.e., based on performance on all item types), and subscales were developed for each of the three reading processes. A note on the interpretation of scale scores may be found in Inset 3.1.

Inset 3.1. A Note on Interpreting Mean Achievement Scores

Interpreting standard errors and constructing confidence intervals. The statistics in this chapter represent estimates of performance based on samples of students on subsets of PISA items. The standard error (of sampling) provides an estimate of the degree to which a statistic (such as a country mean score) may be expected to vary about the true (but unknown) population mean. If a Normal distribution is assumed, a 95% confidence interval for a mean (consisting of a region from 1.96 standard errors below the mean to 1.96 standard errors above the mean) may be constructed in such a way that, if the sampling procedure were repeated a large number of times, and the sample statistic re-computed each time, the confidence interval would be expected to contain the population estimate 95% of the time. The mean combined reading literacy score for Irish 15-year olds in PISA is 526.7, with a standard error of 3.24. Hence, it can be stated with 95% confidence that the population mean lies in a band that extends from 520.35 to 533.05 (526.7 +/– (1.96*3.24)).

Interpreting the standard deviation. The standard deviation associated with a mean score provides an indication of the spread of scores in a country. Within a given country, 68% of scores fall within one standard deviation of the mean score. Hence, in the case of Ireland, which had a standard deviation of 93.57 on combined reading literacy (Table 3.1), 68% of students' scores fall within the interval 433.1 to 620.3.

Comparing country mean scores. Comparisons were drawn between the mean achievement scores of participating OECD countries who met agreed criteria with regard to the sampling of schools and students. The comparisons, in which the differences between a country's mean score and those of the other 26 qualifying countries were examined, took into account the standard errors of measurement associated with pairs of mean scores, using a statistic called the standard error of the difference. Further, the critical values associated with the statistical significance of mean score differences, which are based on the standard error of the difference, were adjusted to more conservative levels, with reference to the number of comparisons being made, using the Bonferroni procedure for multiple comparisons (see Insets 4.2 and 4.3, Chapter 4, for more information on this procedure).

Mean Scores on the Combined Reading Literacy Scale

Ireland achieved a mean score of 526.7 on the combined reading literacy scale. Although Ireland ranked fifth overall in terms of mean achievement, just one country, Finland, achieved a significantly higher mean score (546.5) (Table 3.1). Ireland's mean score is not significantly different from those of eight other countries – Canada, New Zealand, Australia, Korea, the United Kingdom, Japan, Sweden and the United States. Seventeen countries, including Austria, Belgium, France and Germany, achieved significantly lower mean scores. Countries with the lowest mean scores on combined reading literacy include Spain, Greece, Portugal and Mexico. Ireland's mean score is also significantly higher than the OECD country mean of 500.

Even though the United States' mean score of 504.4 is lower than those of Austria, Belgium, Iceland and France (all of which have significantly lower scores than Ireland), the large standard error associated with the US mean score means that it is not significantly different from Ireland's.

It is relevant to observe that countries tend to cluster together on the combined reading literacy scale. For example, just 6 score points separate New Zealand (ranked 3rd) from Japan (ranked 8th). Similarly, just 3 points separate Austria (ranked 10th) from the United States (ranked 15th).

Table 3.1. Mean Achievement Scores and Standard Deviations on Combined Reading Literacy – Ireland and OECD Countries

Country	*Mean (SE)*	*SD (SE)*	*Country*	*Mean (SE)*	*SD (SE)*
Finland	546.5 *(2.58)*	89.41 *(2.57)*	USA	504.4 *(7.05)*	104.78 *(2.70)*
Canada	534.3 *(1.56)*	94.63 *(1.05)*	Denmark	496.9 *(2.35)*	98.05 (1.77)
New Zealand	528.8 *(2.78)*	108.17 *(1.97)*	Switzerland	494.4 *(4.25)*	102.02 *(2.02)*
Australia	528.3 *(3.52)*	101.77 *(1.55)*	Spain	492.6 *(2.71)*	84.74 *(1.24)*
Ireland	**526.7 *(3.24)***	**93.57 *(1.69)***	Czech Rep.	491.6 *(2.37)*	96.32 *(1.91)*
Korea Rep. of	524.8 *(2.42)*	69.52 *(1.63)*	Italy	487.5 *(2.91)*	91.41 *(2.71)*
UK	523.4 *(2.56)*	100.49 *(1.47)*	Germany	484.0 *(2.47)*	111.21 *(1.88)*
Japan	522.2 *(5.21)*	85.78 *(3.04)*	Hungary	480.0 *(3.95)*	93.86 *(2.09)*
Sweden	516.3 *(2.20)*	92.17 *(1.16)*	Poland	479.1 *(4.46)*	99.79 *(3.08)*
Austria	507.1 *(2.40)*	93.00 *(1.60)*	Greece	473.8 *(4.97)*	97.14 *(2.67)*
Belgium	507.1 *(3.56)*	107.03 *(2.42)*	Portugal	470.2 *(4.52)*	97.14 *(1.80)*
Iceland	506.9 *(1.45)*	92.35 *(1.38)*	Luxembourg	441.3 *(1.59)*	100.44 *(1.46)*
Norway	505.3 *(2.80)*	103.65 *(1.65)*	Mexico	422.0 *(3.31)*	85.85 *(2.09)*
France	504.7 *(2.73)*	91.74 *(1.69)*			
			OECD Country Avg.	**500.0 *(0.60)***	**100.0 *(0.40)***

Mean achievement significantly higher than Ireland
Mean achievement not significantly different from Ireland
Mean achievement significantly lower than Ireland
SE = Standard error

Mean Scores on the Three Reading Subscales

As indicated earlier, PISA formed reading subscales based on retrieving information, interpreting information, and reflecting on and evaluating the content and structure of texts. The OECD mean scores on these scales vary slightly from the mean of 500.0 that was set for the overall reading literacy scale.

Retrieve Scale

Questions categorised as 'Retrieve' (retrieving information) required readers to achieve an initial understanding of a text. They included identifying the main idea or topic, explaining the purpose of a map or graph, matching a piece of text to a question about the purpose of the text, and deducing the theme of a text. They also included locating and selecting relevant information in a text, including, where appropriate, such elements as character, time and setting.[17]

The performance of Irish students on the Retrieve subscale is broadly in line with their performance on the combined reading literacy scale. They achieved a mean score of 524.3, and a ranking of 7th (Table 3.2). Just one country, Finland, achieved a significantly higher mean score (556.4). Nine countries achieved scores on the Retrieve scale that are not significantly different from Ireland's – Canada, Australia, New Zealand, Korea, Sweden, Japan, the United Kingdom, Belgium and the United States. Among the countries with significantly lower scores than Ireland are France and Germany.

[17] A detailed description of the knowledge and processes associated with the three reading literacy subscales may be found in Figure 3.1.

Interpret Scale

Questions categorised as 'interpret' (developing an interpretation) required readers to extend their initial impressions of the text by processing it in such a way that they could develop a more specific or complete understanding of what they had read. Such questions included comparing and contrasting information by integrating two or more pieces of information from the text, drawing inferences about the relationship between different sources of information, and identifying and listing supporting information to infer the author's intent.

Table 3.2. Mean Achievement Scores on the Retrieve, Interpret and Reflect/Evaluate Subscales – Ireland and OECD Countries

Country*	*Retrieve* Mean (SE)	*Interpret* Mean (SE)	*Reflect/Evaluate* Mean (SE)
Finland	556.4 *(2.76)*	554.7 *(2.86)*	533.1 *(2.70)*
Canada	530.1 *(1.68)*	531.7 *(1.57)*	542.5 *(1.56)*
New Zealand	534.7 *(2.84)*	526.5 *(2.73)*	529.5 *(2.93)*
Australia	535.6 *(3.71)*	526.8 *(3.53)*	526.3 *(3.45)*
Ireland	**524.3 *(3.25)***	**526.5 *(3.29)***	**533.2 *(3.10)***
Korea Rep. of	529.6 *(2.46)*	524.7 *(2.30)*	526.0 *(2.62)*
UK	523.3 *(2.53)*	514.2 *(2.53)*	538.7 *(2.54)*
Japan	526.0 *(5.46)*	518.0 *(4.98)*	529.6 *(5.45)*
Sweden	515.7 *(2.41)*	521.7 *(2.11)*	510.0 *(2.28)*
Austria	501.8 *(2.30)*	508.2 *(2.44)*	512.2 *(2.69)*
Belgium	514.7 *(3.92)*	511.8 *(3.17)*	496.5 *(4.30)*
Iceland	499.8 *(1.56)*	514.2 *(1.43)*	501.3 *(1.33)*
Norway	504.6 *(2.90)*	505.1 *(2.76)*	506.4 *(2.96)*
France	514.9 *(2.98)*	505.6 *(2.71)*	496.2 *(2.86)*
USA	499.1 *(7.36)*	504.8 *(7.10)*	506.7 *(7.06)*
Denmark	497.6 *(2.77)*	494.4 *(2.42)*	500.5 *(2.64)*
Switzerland	497.7 *(4.40)*	496.0 *(4.15)*	487.6 *(4.83)*
Spain	483.5 *(2.97)*	491.0 *(2.63)*	505.7 *(2.81)*
Czech Rep.	481.1 *(2.66)*	500.4 *(2.40)*	484.8 *(2.60)*
Italy	488.1 *(3.14)*	489.0 *(2.63)*	482.8 *(3.14)*
Germany	483.2 *(2.39)*	487.6 *(2.47)*	478.4 *(2.89)*
Hungary	477.7 *(4.42)*	480.1 *(3.75)*	480.7 *(4.27)*
Poland	475.1 *(4.97)*	482.4 *(4.26)*	477.2 *(4.74)*
Greece	450.1 *(5.37)*	475.2 *(4.49)*	494.6 *(5.58)*
Portugal	455.2 *(4.87)*	472.9 *(4.26)*	479.5 *(4.51)*
Luxembourg	433.0 *(1.62)*	445.9 *(1.56)*	442.3 *(1.87)*
Mexico	402.1 *(3.89)*	418.7 *(2.92)*	445.6 *(3.73)*
OECD Country Average	**497.6 *(0.70)***	**501.0 *(0.62)***	**501.8 *(0.67)***

*Countries are ordered by achievement on the combined reading literacy scale

Mean achievement significantly higher than Ireland

Mean achievement not significantly different from Ireland

Mean achievement significantly lower than Ireland

SE = Standard Error

On the Interpret subscale, Finland's mean score (554.7) is significantly higher than that of any other country (Table 3.2). Ireland achieved a mean score of 526.5, and a ranking of joint 4th with New Zealand. Seven countries achieved mean scores that are not significantly different from Ireland's – Canada, Australia, Korea, Sweden, Japan, Iceland and the United Kingdom. Ireland's mean score is significantly higher than the OECD country average. Whereas Belgium achieved a mean score on the Retrieve subscale that is not significantly different from Ireland, its score on the Interpret subscale is significantly lower. In general, however, countries with high scores on the Retrieve subscale also have high scores on the Interpret subscale.

Reflect/Evaluate Scale

Questions categorised as Retrieve/Evaluate required readers to reflect on the content and the form of texts. Students were asked to assess claims in the text against their own knowledge, or against information found in other texts in the assessment, and to evaluate the quality and appropriateness of texts. In this category, students were asked to provide evidence or arguments from outside the text, assess the relevance of particular pieces of information, identify information that might strengthen an author's argument, and evaluate the sufficiency of evidence or information provided in the text. Students were also asked to determine the utility of a text for a specific purpose, evaluate the author's use of certain technical features in accomplishing a particular goal, and identify or comment on the author's use of style.

Canada achieved the highest score on the Reflect/Evaluate subscale (542.5). However, it is among a group of seven countries with mean achievement scores that are not significantly different from Ireland's (the United Kingdom, Finland, Japan, New Zealand, Australia, and Korea). Ireland, with a mean score of 533.2, is ranked 3rd. Two countries, Sweden and the United States, which achieved mean scores that are not significantly different from Ireland's on the combined reading literacy scale and on the Retrieve and Interpret subscales, achieved significantly lower scores on the Reflect/Evaluate scale. It is interesting to observe that, whereas Finland achieved significantly higher mean scores than any other country on the combined reading literacy scale and on the Retrieve and Interpret subscales, it achieved a mean score that is not significantly different from those of seven other countries with high scores on the Reflect/Evaluate subscale. [18]

Performance on the Reading Proficiency Levels

To represent degrees of proficiency along the combined reading literacy scale, and the three reading literacy subscales, each was divided into five levels (see Inset 3.2). On the combined reading literacy scale, students who achieve at Level 5, the highest level, are capable of completing the most complex PISA reading tasks, such as managing information that is difficult to find in unfamiliar texts, showing detailed understanding of such texts, inferring what information is relevant to selected comprehension tasks, evaluating texts critically, and drawing on specialised information. Students who achieve at Level 1, the lowest level, are capable of completing only the least complex reading tasks developed for PISA, such as locating a single piece of information, identifying the main theme of a text, or making a simple connection with everyday knowledge. A more complete description of the PISA proficiency levels for the combined reading literacy scale may be found in Table 3.3.

Some students were unable to demonstrate proficiency on Level 1 tasks (i.e., their pattern of response indicated that they would not be expected to successfully solve half of the tasks drawn from Level 1). These students fall into the category, 'below Level 1'. According to the OECD, such students have serious difficulties in using reading literacy as an effective tool to advance and extend their knowledge and skills in other areas, may be at risk in the transition from education to work, and may not benefit from further education and learning throughout their lives (OECD, 2001).

Proportionally more students in Ireland (14.2%) than the OECD country average (9.4%) achieved Level 5 – the highest level – on the combined reading literacy scale (Table 3.3). On the other hand, just 11.0% of Irish students, compared with the OECD country average of 17.9%, achieved Level 1 or below.

[18] The reader is referred to Chapter 2 of the PISA International Report (OECD, 2001a) for tables of multiple comparisons, in which each country's mean scores on combined reading literacy, and on the three reading subscales, are compared with those of every other participating country.

Inset 3.2. Interpreting Reading Proficiency Levels in PISA

What are PISA reading proficiency levels? The application of techniques associated with item response theory to the PISA achievement data means that it is possible to generate a criterion-referenced interpretation of student performance along the combined reading literacy scale and the Retrieve, Interpret, Reflect/Evaluate subscales. Item response techniques enable analysts to place test items and students undertaking the items along the same scale. The development of the proficiency levels involved establishing appropriate cut-off points, and describing the skills and knowledge demonstrated by students at each proficiency level. The process of developing proficiency levels was an iterative one in which members of the PISA Reading and Technical Expert Groups worked together to establish and describe levels.

PISA proficiency levels were defined in such a way that a student at the bottom of a level has an average probability of .50 of succeeding on the items at that level. Application of this criterion, and a proviso that proficiency levels should be of fixed width (.80 logits), led to the establishment of a response probability convention of .62*. The resulting cut-off points are given below. The label 'below Level 1' is assigned to students who did not meet the criterion for Level 1 (i.e., the estimated probability of these students responding correctly to items at the bottom of Level 1 is less than .50). PISA does not describe what students below Level 1 can accomplish. Similarly, PISA does not describe the upper limits of the knowledge and skills of students at Level 5 on the scales (i.e., students at this level may have additional skills not assessed by PISA).

Cut-Off Points for PISA Reading Proficiency Levels

Level	*Criteria*
Below Level 1	Equal to or below 334.8
Level 1	Greater than 334.8 and equal to or below 407.5
Level 2	Greater than 407.5 and equal to or below 480.2
Level 3	Greater than 480.2 and equal to or below 552.9
Level 4	Greater than 552.9 and equal to or below 625.6
Level 5	Greater than 625.6

How should PISA reading proficiency levels be interpreted? PISA proficiency levels should be interpreted with reference to the knowledge and skills associated with the items at each proficiency level (see Table 3.3 and Figure 3.1). However, levels can be interpreted in statistical terms along the following lines:

- All students within a level are expected to respond correctly to at least half of the items at that level (since the average probability of succeeding on an item is set at .50 for students at the bottom of the level).
- Students at the bottom of a level have a .62 chance of correctly answering the easiest items on that level and a .42 chance of answering the hardest items.
- Students at the top of a level have a .62 chance of correctly answering the most difficult items at that level, and a .78 chance of answering the easiest items.
- Students just below the top of a level are expected to respond correctly to less than 50% on the items at the next highest level.

*The response probability convention in the International Adult Literacy Survey was set at .80, resulting in larger proportions of adults achieving the lower levels of proficiency, and smaller proportions achieving the higher levels.

Countries with the highest mean scores on combined reading literacy have the highest percentages of students scoring at Level 5 on the combined scale (Table 3.4). For example, 18.5% of students in Finland, 17.6% in Australia, and 15.6% in the UK achieved

Level 5. On the other hand, just 5.0% of students in Greece and 0.9% in Mexico achieved this level. Countries with relatively low mean scores have relatively large percentages of students at Level 1 or below. These included Portugal (24.3%), Greece (24.4%), Luxembourg (35.1%), and Mexico (44.2%).

Table 3.3. Brief Descriptions of Proficiency Levels on Combined Reading Literacy Scale, and Percentages of Students Achieving Each Level – Ireland and OECD

Level	*Brief Description*	*Ireland* *Percent of Students*** *(SE)*	*OECD** *Percent of Students (SE)*
Level 5	Can complete the most complex PISA reading tasks, including managing information that is difficult to locate in complex texts, evaluating texts critically, and drawing on specialised information.	14.2 *(0.83)*	9.5 *(0.14)*
Level 4	Can complete difficult reading tasks, such as locating embedded information, constructing meaning from nuances of language, and critically evaluating a text.	27.1 *(1.10)*	22.3 *(0.18)*
Level 3	Can complete reading tasks of moderate complexity, including locating multiple pieces of information, drawing links between different parts of a text, and relating text information to familiar everyday knowledge.	29.7 *(1.11)*	28.7 *(0.21)*
Level 2	Can complete basic reading tasks, including locating one or more pieces of information which may require meeting multiple criteria, making low-level inferences of various types, and using some outside knowledge to understand text.	17.9 *(0.90)*	21.7 *(0.17)*
Level 1	Can complete the most basic PISA reading tasks, such as locating a single piece of information, identifying the main theme of a text, and making a simple connection with everyday knowledge.	7.9 *(0.81)*	11.9 *(0.17)*
Below Level 1	Has a less than .50 chance of responding correctly to Level 1 tasks. Reading abilities not assessed by PISA.	3.1 *(0.45)*	6.0 *(0.13)*

*Denotes OECD Country Average
**N (Ireland) = 3854

Students' proficiency in reading literacy can also be examined in terms of their performance on the three reading literacy subscales – Retrieve, Interpret and Reflect/Evaluate (see Figure 3.1 for a description of the knowledge and skills characterising the performance of students at each level on each of the three subscales). The proportions of Irish students represented at each proficiency level on the three subscales are broadly similar to the proportions at each level on the combined reading literacy scale (Table 3.5). However, it is also apparent that, relative to their performance on the Retrieve and Interpret subscales, Irish students did marginally better on the Reflect/Evaluate subscale. For example, whereas 41.0% of students achieved Levels 4 or 5 on the Retrieve subscale, 44.0% did so on the Reflect/Evaluate subscale. A similar trend is noted across OECD countries, with 32.8% of students achieving Levels 4 or 5 on the Retrieve subscale, and 33.4% achieving at one or other of these levels on the Reflect/Evaluate subscale (OECD, 2001a).

Some countries show broad differences in achievement across the reading proficiency subscales. In Finland, for example, 25.5% of students achieve Level 5 on the Retrieve subscale, whereas just 14.1% do so on the Reflect/Evaluate subscale. On the other hand, in Mexico, 1.2% of students achieve Level 5 on the Retrieve subscale compared to 4.8% on the Reflect/Evaluate subscale (see OECD, 2001a).

Figure 3.1. Definitions, Task Characteristics, and Description of Knowledge and Skills Underpinning PISA Reading Proficiency Levels, by Subscale

	Retrieve	*Interpret*	*Reflect/Evaluate*
Definition	Locating one or more pieces of information in text	Constructing meaning and drawing inferences from one or more parts of a text	Relating a text to one's experience, knowledge and ideas.
Charac -teristics	Task difficulty depends on the number of pieces of information that need to be located. It also depends on the number of conditions that must be met to locate the requested information, and on whether what is retrieved needs to be sequenced in a particular way.	Task difficulty depends on type of interpretation required, with the easiest tasks requiring identification of a main idea in a text, intermediate tasks requiring understanding relationships that are part of the text, and the most difficult tasks requiring either an understanding of meaning of language in context or analogical reasoning. Difficulty also depends on explicitness of text information.	Task difficulty depends on the type of reflection required, with the easiest tasks requiring simple connections or explanations, and the more difficult tasks requiring a hypothesis or evaluation. Difficulty also depends on the familiarity of the knowledge that must be drawn on from outside the text, on the complexity of the text, on the level of textual understanding required, and on how explicitly the reader is directed to relevant factors in both the tasks and the text.
Level 5	Locate and possibly sequence multiple pieces of deeply embedded information, some of which may be outside the main body of the text. Infer which information in the text is relevant. Deal with highly implausible and/or extensive competing information.	Either construe the meaning of nuanced language or demonstrate a full, detailed understanding of the text.	Critically evaluate or hypothesise, drawing on specialised knowledge. Deal with concepts that are contrary to expectations, and draw on a deep understanding of long or complex texts.
Level 4	Locate and possibly sequence or combine multiple pieces of information, each of which may need to meet multiple criteria, in a text with unfamiliar context or form. Infer which information in the text is relevant.	Use a high level of text-based inferences to understand and apply categories in an unfamiliar context, and to construe the meaning of a section of text by taking into account the text as a whole. Deal with ambiguities, ideas that are contrary to expectation, and ideas that are negatively worded.	Use formal or public knowledge to hypothesise about or critically evaluate a text. Demonstrate a detailed understanding of the text in relation to familiar, everyday knowledge, or draw on less common knowledge.
Level 3	Locate, and in some cases recognise, the relationship between pieces of information, each of which may need to meet multiple criteria. Deal with competing information that is prominent.	Integrate several parts of the text in order to identify a main idea, understand a relationship, or construe the meaning of a word or phrase. Compare, contrast or construe meaning within a limited part of the text when the information is not prominent, and low-level inferences are required.	Make connections or comparisons, give explanations or evaluate a feature of text. Demonstrate a detailed understanding of the text in relation to familiar, everyday knowledge, or draw on less-common knowledge.
Level 2	Locate one or more pieces of information, each of which may be required to meet multiple criteria. Deal with competing information.	Identify the main idea in a text, understand relationships, form or apply simple categories, or construe meaning within a limited part of the text when the information is not prominent and low-level inferences are required.	Make a comparison or connections between information in the text or outside knowledge, or explain a feature of the text by drawing on personal experience and attitudes.
Level 1	Take into account a single criterion to locate one or more pieces of explicitly-stated information.	Recognise the main theme or author's purpose in a text about a familiar topic, when the required information is prominent.	Make a simple connection between information in the text and common everyday knowledge.

Table 3.4. Percentages of Students Achieving Each Proficiency Level on the Combined Reading Literacy Scale – Ireland and OECD Countries

Country	Combined Reading Literacy < Level 1 % (SE)	Level 1 % (SE)	Level 2 % (SE)	Level 3 % (SE)	Level 4 % (SE)	Level 5 % (SE)
Finland	1.7 (0.51)	5.2 (0.44)	14.3 (0.67)	28.7 (0.80)	31.6 (0.90)	18.5 (0.91)
Canada	2.4 (0.26)	7.2 (0.31)	18.0 (0.43)	28.0 (0.47)	27.7 (0.57)	16.8 (0.50)
New Zealand	4.8 (0.50)	8.9 (0.50)	17.2 (0.90)	24.6 (1.10)	25.8 (1.10)	18.7 (1.00)
Australia	3.3 (0.46)	9.1 (0.75)	19.0 (1.06)	25.7 (1.08)	25.3 (0.87)	17.6 (1.23)
Ireland	**3.1 (0.45)**	**7.9 (0.81)**	**17.9 (0.90)**	**29.7 (1.11)**	**27.1 (1.10)**	**14.2 (0.83)**
Korea Rep. of	0.9 (0.21)	4.8 (0.63)	18.6 (0.91)	38.1 (1.06)	31.1 (1.15)	5.7 (0.63)
UK	3.6 (0.39)	9.2 (0.52)	19.6 (0.66)	27.5 (0.90)	24.4 (0.92)	15.6 (0.95)
Japan	2.7 (0.64)	7.3 (1.08)	18.0 (1.25)	33.3 (1.28)	28.8 (1.68)	9.9 (1.11)
Sweden	3.3 (0.42)	9.3 (0.64)	20.3 (0.72)	30.4 (1.02)	25.6 (1.00)	11.2 (0.70)
Austria	4.4 (0.43)	10.2 (0.56)	21.7 (0.89)	29.9 (1.18)	24.9 (1.03)	8.8 (0.76)
Belgium	7.7 (0.98)	11.3 (0.74)	16.8 (0.68)	25.8 (0.87)	26.3 (0.90)	12.0 (0.66)
Iceland	4.0 (0.34)	10.5 (0.60)	22.0 (0.77)	30.8 (0.89)	23.6 (1.10)	9.1 (0.72)
Norway	6.3 (0.56)	11.2 (0.79)	19.5 (0.84)	28.1 (0.83)	23.7 (0.87)	11.2 (0.71)
France	4.2 (0.55)	11.0 (0.78)	22.0 (0.80)	30.6 (0.97)	23.7 (0.90)	8.5 (0.55)
USA	6.4 (1.21)	11.5 (1.19)	21.0 (1.17)	27.4 (1.28)	21.5 (1.38)	12.2 (1.36)
Denmark	5.9 (0.62)	12.0 (0.72)	22.5 (0.86)	29.5 (1.00)	22.0 (0.86)	8.1 (0.52)
Switzerland	7.0 (0.67)	13.3 (0.86)	21.4 (0.98)	28.0 (1.03)	21.0 (0.98)	9.2 (1.04)
Spain	4.1 (0.54)	12.2 (0.91)	25.7 (0.74)	32.8 (0.95)	21.1 (0.88)	4.2 (0.49)
Czech Rep.	6.1 (0.61)	11.4 (0.66)	24.8 (1.17)	30.9 (1.14)	19.8 (0.81)	7.0 (0.55)
Italy	5.4 (0.85)	13.5 (0.87)	25.6 (1.01)	30.6 (1.00)	19.5 (1.09)	5.3 (0.50)
Germany	9.9 (0.71)	12.7 (0.62)	22.3 (0.82)	26.8 (0.99)	19.4 (1.01)	8.8 (0.51)
Hungary	6.9 (0.73)	15.8 (1.15)	25.0 (1.09)	28.8 (1.31)	18.5 (1.09)	5.1 (0.76)
Poland	8.7 (1.01)	14.6 (1.01)	24.1 (1.39)	28.2 (1.34)	18.6 (1.32)	5.9 (0.95)
Greece	8.7 (1.20)	15.7 (1.37)	25.9 (1.36)	28.1 (1.70)	16.7 (1.36)	5.0 (0.65)
Portugal	9.6 (1.00)	16.7 (1.18)	25.3 (0.98)	27.5 (1.15)	16.8 (1.09)	4.2 (0.54)
Luxembourg	14.2 (0.67)	20.9 (0.75)	27.5 (1.31)	24.6 (1.07)	11.2 (0.50)	1.7 (0.30)
Mexico	16.1 (1.22)	28.1 (1.39)	30.3 (1.12)	18.8 (1.15)	6.0 (0.74)	0.9 (0.24)
OECD Country Avg.	**6.0 (0.13)**	**11.9 (0.17)**	**21.7 (0.17)**	**28.7 (0.21)**	**22.3 (0.18)**	**9.5 (0.14)**

Note. Countries are ordered in descending order of country mean score.

Table 3.5. Percentages of Students Achieving Each Proficiency Level on the Retrieve, Interpret and Reflect/Evaluate Reading Subscales – Ireland and OECD

Level	Ireland Retrieve % (SE)	Ireland Interpret % (SE)	Ireland Reflect/ Evaluate % (SE)	OECD Country Averages Retrieve % (SE)	OECD Country Averages Interpret % (SE)	OECD Country Averages Reflect/ Evaluate % (SE)
Level 5	15.2 (0.84)	15.2 (0.96)	14.5 (0.86)	11.6 (0.16)	9.9 (0.14)	10.9 (0.17)
Level 4	25.8 (0.86)	26.1 (1.06)	29.5 (1.02)	21.2 (0.17)	21.7 (0.19)	22.5 (0.19)
Level 3	28.1 (1.02)	28.8 (1.12)	30.3 (0.95)	26.1 (0.20)	28.4 (0.26)	27.6 (0.20)
Level 2	18.2 (0.92)	18.2 (0.90)	16.8 (1.00)	20.7 (0.17)	22.3 (0.18)	20.7 (0.17)
Level 1	8.7 (0.69)	8.3 (0.69)	6.6 (0.80)	12.3 (0.15)	12.2 (0.18)	11.4 (0.16)
< Level 1	4.0 (0.48)	3.5 (0.48)	2.4 (0.39)	8.1 (0.16)	5.5 (0.12)	6.8 (0.13)

Variation in Performance on the Combined Reading Literacy Scale

In the previous section, the performance of students across PISA's proficiency levels was described in terms of specified levels of knowledge and skills, relative to *absolute* benchmarks (the proficiency levels). In this section, the focus shifts to a consideration of the *relative* dispersion of scores in Ireland and in other countries, including the gap between the best and poorest performing students. Such a gap may be interpreted as an indicator of the equality of educational outcomes, with a small gap indicating higher levels of equality in outcomes, and a large gap reflecting inequality.

In Ireland, the score of students at the 10th percentile on the combined reading literacy scale is 401.3 (Table 3.6). Students at the 10th percentile in just four OECD countries achieved higher scores – Korea (432.8), Finland (429.0), Canada (409.9) and Japan (407.1). In the United Kingdom, a country with a mean score that is not significantly different from Ireland's, students at the 10th percentile achieved a score of 390.7. This, together with a score of 457.6 at the 25th percentile, points to a somewhat longer tail in the distribution of scores than in Ireland, where students at the 25th percentile achieved a score of 467.9. In New Zealand, another country with an overall combined reading literacy mean score that is not significantly different from Ireland's, students at the 10th and 25th percentiles achieved scores of 381.9 and 459.3 respectively, again pointing to a tail of low achievement.

Table 3.6. Mean Scores of Students Achieving at the 10th, 25th, 75th and 90th Percentiles on the Combined Reading Literacy Scale – Ireland and OECD Countries

Country[*]	*10th Percentile Score (SE)*	*25th Percentile Score (SE)*	*75th Percentile Score (SE)*	*90th Percentile Score (SE)*
Finland	429.0 *(5.14)*	491.9 *(2.94)*	608.0 *(2.60)*	653.6 *(2.77)*
Canada	409.9 *(2.42)*	471.6 *(2.04)*	600.5 *(1.48)*	651.8 *(1.94)*
New Zealand	381.9 *(5.01)*	459.3 *(4.05)*	606.3 *(2.99)*	660.9 *(4.44)*
Australia	394.2 *(4.37)*	458.4 *(4.39)*	602.0 *(4.61)*	655.6 *(4.19)*
Ireland	**401.3 *(6.39)***	**467.9 *(4.28)***	**593.1 *(3.55)***	**641.1 *(4.04)***
Korea Rep. of	432.8 *(4.43)*	481.4 *(2.86)*	573.6 *(2.62)*	608.2 *(2.94)*
UK	390.7 *(4.07)*	457.6 *(2.82)*	594.8 *(3.54)*	650.7 *(4.29)*
Japan	407.1 *(9.77)*	471.2 *(6.98)*	581.7 *(4.39)*	624.9 *(4.55)*
Sweden	391.5 *(4.03)*	456.1 *(3.08)*	581.3 *(3.12)*	630.3 *(2.89)*
Austria	383.1 *(4.23)*	447.0 *(2.78)*	573.2 *(3.01)*	620.8 *(3.24)*
Belgium	354.2 *(8.89)*	437.0 *(6.64)*	586.7 *(2.32)*	633.6 *(2.54)*
Iceland	383.4 *(3.61)*	447.4 *(3.05)*	572.6 *(2.15)*	621.0 *(3.54)*
Norway	363.8 *(5.45)*	440.0 *(4.47)*	579.1 *(2.66)*	631.4 *(3.08)*
France	380.9 *(5.17)*	443.7 *(4.47)*	570.3 *(2.43)*	618.5 *(2.90)*
USA	363.0 *(11.43)*	436.1 *(8.80)*	577.3 *(6.81)*	635.7 *(6.51)*
Denmark	367.1 *(5.02)*	433.8 *(3.31)*	566.0 *(2.72)*	616.8 *(2.89)*
Switzerland	355.5 *(5.76)*	426.3 *(5.54)*	566.9 *(4.65)*	620.9 *(5.48)*
Spain	378.7 *(4.98)*	436.3 *(4.61)*	553.4 *(2.57)*	597.1 *(2.60)*
Czech Rep.	367.9 *(4.93)*	433.3 *(2.75)*	557.5 *(2.85)*	609.6 *(3.19)*
Italy	367.5 *(5.78)*	428.6 *(4.14)*	552.2 *(3.24)*	601.2 *(2.74)*
Germany	335.4 *(6.33)*	417.0 *(4.58)*	562.5 *(3.06)*	619.5 *(2.79)*
Hungary	354.0 *(5.46)*	414.3 *(5.28)*	548.6 *(4.52)*	598.4 *(4.38)*
Poland	343.0 *(6.81)*	413.9 *(5.78)*	550.8 *(5.97)*	603.1 *(6.57)*
Greece	342.4 *(8.42)*	409.2 *(7.37)*	542.9 *(4.54)*	594.7 *(5.13)*
Portugal	337.3 *(6.22)*	402.9 *(6.38)*	541.3 *(4.45)*	592.1 *(4.16)*
Luxembourg	311.2 *(4.43)*	377.6 *(2.78)*	513.5 *(2.00)*	564.4 *(2.79)*
Mexico	311.3 *(3.36)*	360.5 *(3.62)*	482.0 *(4.80)*	534.7 *(5.46)*
OECD Country Avg.	**365.9 *(1.09)***	**435.0 *(0.96)***	**570.6 *(0.69)***	**622.7 *(0.78)***

[*]Countries are ordered by overall achievement in combined reading literacy.

Students at the 90th percentile in Ireland achieved a score of 641.1. This was exceeded by students in five countries – New Zealand (660.0), Australia (655.6), Finland (653.6), Canada (651.8), and the UK (650.7). The relatively high scores of New Zealand and the UK are particularly noteworthy in view of their relatively low scores at the 10th and 25th percentiles, and point to wider distributions of achievement than in Ireland. In Korea, students at the 90th percentile achieved a mean score of 608.2, which, when combined with their relatively high scores at the 10th and 25th percentiles, points to a relatively narrow distribution of achievement in reading literacy.

ACHIEVEMENT IN MATHEMATICAL LITERACY

Whereas reading literacy was a major assessment domain in PISA 2000, mathematics was a minor domain. Two broad areas of mathematics (informally termed 'Big Ideas') were assessed: Change and Growth, and Shape and Space. Other areas such as Quantitative Reasoning, Uncertainty, and Dependency and Relationships were not assessed. Hence, mathematical literacy, as measured in PISA 2000, covers a relatively narrow range of topics. Moreover, since relatively few assessment items were administered to relatively small numbers of students, it was not possible to develop achievement subscales or to establish proficiency levels. In the first part of this section, the interpretation of scores on the mathematical literacy scale is discussed. In subsequent sections, the performance of students in Ireland and in other OECD countries on the scale is summarised in terms of (i) the overall performance of students; and (ii) the performance of students at four key markers in the distribution of achievement (the 10th, 25th, 75th and 90th percentiles).

Interpreting Scores on the Mathematical Literacy Scale

Scores on the mathematical literacy scale reflect the performance of students on a range of mathematical processes. A description of the mathematical knowledge and processes of students at different points along the achievement scale was developed using the same procedures (but with less precision) as those used to identify skills at the different reading proficiency levels (see above). At the top of the mathematical literacy scale (around 750 score points), students could:

- Develop or impose a mathematical interpretation, formulation or construction;
- Interpret more complex information and negotiate a number of processing steps;
- Identify and apply relevant tools and knowledge (frequently in an unfamiliar problem context);
- Demonstrate insight to identify a suitable solution strategy; and
- Display higher-order cognitive processes such as generalisation, reasoning and argumentation to explain or communicate results.

At an intermediate point in the scale (around 570 score points), students could:

- Interpret, link and integrate different representations of a problem or different pieces of information;
- Use and manipulate a given model, often involving algebra or other symbolic representations;
- Verify or check propositions or models;
- Work with given strategies, models or propositions (e.g., by recognising and extending a pattern); and
- Select and apply relevant mathematical knowledge to resolve a problem situation that may involve a small number of processing steps.

At the lower end of the scale (around 380 score points), students could:

- Complete a single processing step consisting of reproducing basic mathematical facts or processes, or applying simple computational skills;
- Recognise information from diagrammatic or text material that is familiar and straightforward and in which formulation is provided or readily available;
- Recognise a single, familiar element of a problem; and
- Solve a problem through application of a single, routine procedure in a single processing step.

Examples of items used in the assessment of mathematical achievement, and the scale scores associated with these items, are given in Appendix 1.

Mean Scores on the Mathematical Literacy Scale

Ireland achieved a mean score of 502.9 on the mathematical literacy scale (Table 3.7). This is not significantly different from the OECD country mean of 500.0. Ireland's ranking in mathematical literacy was 15th of 27 countries. Thirteen countries have mean scores that are significantly higher than Ireland's, including Japan, Korea, the United Kingdom and France. The highest scoring country, Japan, has a mean score that is 54 points greater than Ireland's (i.e., over one half of a standard deviation), while the difference between the mean scores of the second-placed country, Korea, and Ireland is 44 points. The United Kingdom ranks joint 8th with Switzerland, with a mean score of 529.3 – over a quarter of a standard deviation higher than Ireland's.

Among the countries with scores that do not differ significantly from Ireland's are Sweden, the Czech Republic, the United States and Germany. Countries with significantly lower scores include Hungary, Spain, Poland, Portugal, Greece and Mexico. Mexico, the lowest-scoring country, achieved a mean score that is some 169 score points lower than Japan's.

The standard deviation associated with a country's mean score can be interpreted as an indication of the spread of achievement in that country. Just two countries (Finland and Mexico) have lower standard deviations than Ireland's standard deviation of 83.56, indicating that the distribution of mathematical achievement in Ireland is narrower than in many other countries. Belgium, Germany, Greece and Poland all have standard deviations that exceed 100 score points, indicating that achievement is spread more broadly than in Ireland.

Table 3.7. Mean Achievement Scores on Mathematical Literacy – Ireland and OECD Countries

Country	*Mean (SE)*	*SD (SE)*	*Country*	*Mean (SE)*	*SD (SE)*
Japan	**556.6** ***(5.49)***	**86.94** ***(3.12)***	**Ireland**	**502.9** ***(2.72)***	**83.56** ***(1.76)***
Korea Rep. of	**546.8** ***(2.76)***	**84.32** ***(1.99)***	Norway	499.4 *(2.77)*	91.56 *(1.72)*
New Zealand	**536.9** ***(3.14)***	**98.73** ***(1.86)***	Czech Rep.	497.6 *(2.78)*	96.31 *(1.85)*
Finland	**536.2** ***(2.15)***	**80.32** ***(1.35)***	USA	493.2 *(7.64)*	98.34 *(2.41)*
Australia	**533.3** ***(3.49)***	**90.04** ***(1.63)***	Germany	489.8 *(2.52)*	102.53 *(2.41)*
Canada	**533.0** ***(1.40)***	**84.57** ***(1.10)***	Hungary	488.0 *(4.01)*	97.94 *(2.36)*
Switzerland	**529.3** ***(4.38)***	**99.61** ***(2.16)***	Spain	476.3 *(3.12)*	90.51 *(1.48)*
UK	**529.2** ***(2.50)***	**91.66** ***(1.58)***	Poland	470.1 *(5.48)*	102.52 *(3.80)*
Belgium	**519.6** ***(3.90)***	**106.15** ***(2.93)***	Italy	457.4 *(2.93)*	90.41 *(2.41)*
France	**517.2** ***(2.71)***	**89.25** ***(1.87)***	Portugal	453.7 *(4.08)*	91.33 *(1.82)*
Austria	**515.0** ***(2.51)***	**92.44** ***(1.73)***	Greece	446.9 *(5.58)*	108.31 *(2.93)*
Denmark	**514.5** ***(2.44)***	**86.60** ***(1.74)***	Luxembourg	445.7 *(1.99)*	92.55 *(1.77)*
Iceland	**514.4** ***(2.25)***	**84.61** ***(1.41)***	Mexico	387.3 *(3.36)*	82.67 *(1.93)*
Sweden	509.8 *(2.46)*	93.40 *(1.58)*			
			OECD Country Avg.	**500.0** ***(0.73)***	**100.0** ***(0.40)***

[dark grey] Mean achievement significantly higher than Ireland
[white] Mean achievement not significantly different from Ireland
[light grey] Mean achievement significantly lower than Ireland
SE = Standard error

It is interesting to observe that Australia, Canada, Japan, Korea, New Zealand and the United Kingdom, countries with mean scores that are not significantly different from Ireland's on combined reading literacy, all have significantly higher mean scores in mathematical literacy. On the other hand, a number of countries with mean scores in reading literacy that are significantly lower than Ireland's, including Denmark, Austria, Iceland and Switzerland, achieved mean scores on mathematical literacy that are significantly higher. It can therefore be concluded that Ireland's performance relative to other countries is poorer in mathematical literacy than in reading literacy. Just one country, Sweden, experienced a discrepancy in achievement between these two assessment domains that was similar to Ireland's.

Variation in Performance on the PISA Mathematical Literacy Scale

In this section, the performance of students at the 10th, 25th, 75th and 90th percentiles on the mathematical literacy scale is considered (Table 3.8).

Irish students scoring at the 10th percentile on the scale had a score of 394.4. This ranked Ireland 14th among OECD countries at this marker, but well above the OECD average of 366.8. Students at the 10th percentile in Japan and Korea (the two countries with the highest mean scores on mathematical literacy) achieved scores of 440.4 and 438.3 respectively, while their counterparts in the United Kingdom achieved a score of 411.9. Students scoring at the 10th percentile in Mexico, the country with the lowest mean score on the mathematical literacy scale, had a score of 280.7. Thus, there is a gap of some 160 points (over one and a half standard deviations) between the scores of students at the 10th percentiles in Japan and Mexico.

Table 3.8. Mean Scores of Students Achieving at the 10th, 25th, 75th and 90th Percentiles on the Mathematical Literacy Scale – Ireland and OECD Countries

*Country**	*10th Percentile Score (SE)*	*25th Percentile Score (SE)*	*75th Percentile Score (SE)*	*90th Percentile Score (SE)*
Japan	440.4 *(9.12)*	503.8 *(7.38)*	616.7 *(5.23)*	662.1 *(4.89)*
Korea Rep. of	438.3 *(5.01)*	493.4 *(4.15)*	605.8 *(3.43)*	649.5 *(4.34)*
New Zealand	405.3 *(5.43)*	471.9 *(3.92)*	607.1 *(3.96)*	659.2 *(4.24)*
Finland	433.1 *(3.61)*	484.0 *(4.08)*	592.2 *(2.51)*	636.6 *(3.18)*
Australia	418.1 *(6.35)*	473.7 *(4.40)*	594.3 *(4.48)*	647.3 *(5.66)*
Canada	423.0 *(2.54)*	476.5 *(1.98)*	591.9 *(1.74)*	639.7 *(1.91)*
Switzerland	397.7 *(5.99)*	465.7 *(4.84)*	600.6 *(5.21)*	653.1 *(5.79)*
UK	411.9 *(3.60)*	469.8 *(3.19)*	592.4 *(3.24)*	646.0 *(4.28)*
Belgium	367.1 *(8.63)*	453.2 *(6.46)*	597.3 *(2.99)*	646.0 *(3.93)*
France	398.6 *(5.35)*	457.0 *(4.72)*	581.2 *(3.05)*	629.3 *(3.22)*
Austria	392.1 *(4.56)*	454.6 *(3.52)*	580.5 *(3.76)*	630.6 *(3.55)*
Denmark	401.5 *(5.08)*	458.4 *(3.07)*	575.2 *(3.05)*	620.6 *(3.70)*
Iceland	406.5 *(4.65)*	459.3 *(3.48)*	572.3 *(3.03)*	621.9 *(3.11)*
Sweden	386.3 *(4.03)*	450.1 *(3.34)*	574.3 *(2.56)*	625.6 *(3.31)*
Ireland	**394.4 *(4.69)***	**448.9 *(4.06)***	**561.1 *(3.61)***	**606.2 *(4.28)***
Norway	379.1 *(5.21)*	439.0 *(4.01)*	564.7 *(3.85)*	613.2 *(4.53)*
Czech Rep.	371.7 *(4.16)*	432.9 *(4.09)*	563.6 *(3.94)*	622.5 *(4.84)*
USA	360.8 *(9.60)*	426.6 *(9.69)*	562.2 *(7.50)*	620.3 *(7.70)*
Germany	348.9 *(6.90)*	422.5 *(3.89)*	562.7 *(2.68)*	619.0 *(3.55)*
Hungary	359.7 *(5.65)*	418.5 *(4.84)*	557.5 *(5.24)*	615.0 *(6.35)*
Spain	358.3 *(4.33)*	416.0 *(5.34)*	539.7 *(3.98)*	591.8 *(3.92)*
Poland	335.3 *(9.16)*	402.1 *(7.04)*	542.4 *(6.84)*	599.4 *(7.74)*
Italy	338.5 *(5.48)*	398.0 *(3.52)*	520.1 *(3.50)*	569.7 *(4.37)*
Portugal	331.8 *(6.14)*	392.3 *(5.66)*	520.4 *(4.32)*	569.8 *(4.26)*
Greece	303.4 *(8.13)*	374.7 *(8.07)*	524.0 *(6.66)*	585.7 *(7.78)*
Luxembourg	327.5 *(4.19)*	390.0 *(3.78)*	508.8 *(3.44)*	558.8 *(3.17)*
Mexico	280.7 *(3.56)*	329.1 *(4.09)*	444.5 *(5.22)*	496.1 *(5.57)*
OECD Country Avg.	**366.8 *(1.43)***	**434.9 *(1.05)***	**570.8 *(0.83)***	**624.8 *(0.88)***

*Countries are ordered by overall achievement in mathematical literacy.

Irish students scoring at the 90th percentile achieved a score of 606.2, yielding a rank of 20th at this marker. Ireland's score is some 19 points below the OECD average of 624.9 and 55.9 points (over one half of a standard deviation) below Japan. Students in the United Kingdom achieved a score of 646.0 at the 90th percentile. Among countries with mean scores on the mathematical literacy scale that are not significantly different from Ireland's

(Sweden, Norway, the Czech Republic, the US, and Germany), Ireland has the lowest score at the 90th percentile.

Across OECD countries, the difference between scores at the 25th and 75th percentiles extend from 108.2 (Finland) to 149.2 (Greece). For Ireland, the difference (112.1) is the second smallest. A small difference can be associated with relatively high achievement (as in Korea and Japan), or with average achievement (as in Ireland). In general, the difference between scores at the 25th and 75th percentiles tends to be greater in lower-scoring countries (for example, Greece and Poland) than in higher-scoring countries.

ACHIEVEMENT IN SCIENTIFIC LITERACY

Like mathematical literacy, scientific literacy was a minor assessment domain in PISA. The scientific literacy scale measured students' ability to use scientific knowledge (understanding of scientific concepts), to recognise scientific questions and to identify what is involved in scientific investigations (understanding of the nature of scientific investigation), to relate scientific data to claims and conclusions (using scientific evidence), and to communicate these aspects of science. PISA scientific literacy assesses the application of scientific concepts in real world situations. Specific areas of application include science in life and health, science in earth and environment, and science in technology. This section addresses the interpretation of scores on the scientific literacy scale, the overall performance of students in Ireland and in other OECD countries, and the performance of Irish students at four key markers (the 10th, 25th, 75th and 90th percentiles).

Interpreting Scores on the Scientific Literacy Scale

As with mathematical literacy, it was not possible to develop separate proficiency skills for different aspects of scientific literacy. However, it was possible to generate a description of the skills associated with different points along the scientific literacy scale using the same procedures that were used to describe the skills associated with proficiency levels on the PISA reading literacy subscales (see above).

Towards the top of the scientific literacy scale (around 690 points), students demonstrated ability to complete the following tasks:

- Create or use simple conceptual models to make predictions or give explanations;
- Analyse scientific investigations in relation to experimental design;
- Relate data as evidence to evaluate alternative viewpoints or different perspectives; and
- Communicate scientific arguments and/or descriptions in detail and with precision.

At an intermediate point on the scale (around 550 points), students showed that they could:

- Use scientific concepts to make predictions or give explanations;
- Recognise questions that can be answered by scientific investigation and/or identify details of what is involved in a scientific investigation; and
- Select relevant information from competing data or chains of reasoning in drawing or evaluating conclusions.

Towards the lower end of the scale (around 400 score points), students could:

- Recall simple scientific factual knowledge (e.g., names, facts, terminology, simple rules); and
- Use common science knowledge in drawing or evaluating conclusions.

Examples of contexts and items used to assess students' scientific literacy may be found in Appendix 1, where scale score values for selected scientific literacy items are also given.

Mean Scores on the Scientific Literacy Scale

Ireland achieved a mean score of 513.4 on the scientific literacy scale (Table 3.9). This is significantly higher than the OECD country average of 500.0. Ireland's ranking in scientific literacy is 9th of 27 countries. Countries with mean scores that are significantly higher than Ireland's are Korea, Japan, Finland, the United Kingdom, Canada and New Zealand. The highest scoring country, Korea, has a mean score that is 38.7 points (almost two-fifths of a standard deviation) higher than Ireland's. There is a smaller gap (18.6 points) between the mean scores of the United Kingdom and Ireland.

Eight countries (Austria, Denmark, Iceland, Norway, Sweden, the Czech Republic, United States, and Germany) have mean scores that are not significantly different from Ireland's. Countries with significantly lower scores include Poland, Portugal, Luxembourg and Mexico. The standard deviation associated with Ireland's mean score is 91.74 – some 8 points lower than the OECD country average. The United Kingdom (with a significantly higher mean score) and the United States have standard deviations that are closer to the OECD average, indicating broader distributions of achievement than in Ireland. The standard deviation for the highest achieving country, Korea, is just 80.67.

Table 3.9. Mean Achievement Scores on Scientific Literacy – Ireland and OECD Countries

Country	*Mean (SE)*	*SD (SE)*	*Country*	*Mean (SE)*	*SD (SE)*
Korea Rep. of	**552.1** ***(2.69)***	**80.67** ***(1.81)***	Hungary	496.1 *(4.17)*	102.52 *(2.31)*
Japan	**550.4** ***(5.48)***	**90.47** ***(3.00)***	Iceland	495.9 *(2.17)*	87.78 *(1.60)*
Finland	**537.7** ***(2.48)***	**86.29** ***(1.21)***	Belgium	495.7 *(4.29)*	110.97 *(3.81)*
UK	**532.0** ***(2.69)***	**98.18** ***(2.02)***	Switzerland	495.7 *(4.44)*	100.06 *(2.43)*
Canada	**529.4** ***(1.57)***	**88.84** ***(1.05)***	Spain	490.9 *(2.95)*	95.38 *(1.76)*
New Zealand	**527.7** ***(2.40)***	**100.74** ***(2.25)***	Germany	487.1 *(2.43)*	101.95 *(1.96)*
Australia	527.5 *(3.47)*	94.23 *(1.56)*	Poland	483.1 *(5.12)*	96.84 *(2.70)*
Austria	518.6 *(2.55)*	91.25 *(1.74)*	Denmark	481.0 *(2.81)*	103.21 *(1.99)*
Ireland	**513.4** ***(3.18)***	**91.74** ***(1.71)***	Italy	477.6 *(3.05)*	98.04 *(2.59)*
Sweden	512.1 *(2.51)*	93.21 *(1.42)*	Greece	460.6 *(4.89)*	96.90 *(2.57)*
Czech Rep.	511.4 *(2.43)*	93.92 *(1.51)*	Portugal	459.0 *(4.00)*	89.01 *(1.61)*
France	500.5 *(3.18)*	102.36 *(1.98)*	Luxembourg	443.1 *(2.32)*	96.34 *(1.95)*
Norway	500.3 *(2.75)*	95.54 *(2.04)*	Mexico	421.5 *(3.18)*	77.07 *(2.09)*
USA	499.5 *(7.31)*	101.08 *(2.92)*			
			OECD Country Avg.	**500.0** ***(0.65)***	**100.0** ***(0.46)***

Mean achievement significantly higher than Ireland (dark shading)
Mean achievement not significantly different from Ireland (no shading)
Mean achievement significantly lower than Ireland (light shading)
SE = Standard error

It is interesting to observe that all six countries with significantly higher mean scores in scientific literacy than Ireland also have significantly higher mean mathematical literacy scores. However, just one of the six, Finland, has a significantly higher score on combined reading literacy. Six additional countries, with significantly higher mean scores on mathematical literacy than Ireland, have mean scores in scientific literacy that are not significantly different from Ireland's. Hence, in relative terms, Ireland's performance in scientific literacy is better than in mathematical literacy, but poorer than in combined reading literacy.

Variation in Performance on the Scientific Literacy Scale

In this section, the performance of students at the 10th, 25th, 75th and 90th percentiles on the scientific literacy scale is considered (Table 3.10).

Irish students at the 10th percentile achieved a score of 394.4. This score ranks Ireland 7th among OECD countries at this marker. New Zealand, which has a significantly higher mean scientific literacy score than Ireland, has a score at the 10th percentile that is some 2 points lower. Although just 2 score points separate the mean scientific literacy scores of Korea and Japan, Korea's score at the 10th percentile was about 12 points higher. However, since there are large standard errors associated with scores of these countries at the 10th percentile, the difference is not statistically significant. The difference in scores at the 10th percentile between the countries with the highest and lowest mean scores in scientific literacy (Korea and Mexico) is 117.0 score points – about 1.2 standard deviations on the international scale.

The score of Irish students at the 90th percentile on the scientific literacy scale is 630.2 – giving a ranking of 10th. The scores at the 90th percentile for countries with significantly higher mean scores than Ireland's range from 651.7 (Korea) to 640.9 (Canada). Therefore, the highest achieving students in those countries outperform students in Ireland. The score at the 90th percentile in the United Kingdom is some 25.9 points (one quarter of a standard deviation) higher than the equivalent score in Ireland.

In Ireland, the difference between scores at the 25th and 75th percentiles is 128.8 points – some 12 points lower than the OECD country average. However, there is no apparent relationship between the size of the difference and overall achievement, as countries with the smallest differences include those with high mean scores (Korea, Japan and Finland), and those with low mean scores (Mexico and Luxembourg).

Table 3.10. Mean Scores of Students Achieving at the 10th, 25th, 75th and 90th Percentiles on the Scientific Literacy Scale – Ireland and OECD Countries

Country[*]	*10th Percentile Score (SE)*	*25th Percentile Score (SE)*	*75th Percentile Score (SE)*	*90th Percentile Score (SE)*
Korea Rep. of	442.5 *(5.27)*	498.8 *(4.02)*	610.2 *(3.41)*	651.7 *(3.86)*
Japan	430.0 *(9.87)*	495.3 *(7.15)*	612.3 *(5.01)*	659.3 *(4.70)*
Finland	424.8 *(4.17)*	480.5 *(3.53)*	598.0 *(3.00)*	645.5 *(4.25)*
UK	401.5 *(5.97)*	466.0 *(3.81)*	601.6 *(3.90)*	656.1 *(4.73)*
Canada	411.8 *(3.39)*	469.0 *(2.22)*	591.9 *(1.75)*	640.9 *(2.19)*
New Zealand	392.5 *(5.16)*	458.8 *(3.80)*	600.2 *(3.42)*	653.0 *(4.96)*
Australia	402.4 *(4.73)*	463.4 *(4.59)*	595.6 *(4.84)*	646.4 *(5.08)*
Austria	397.7 *(3.95)*	456.1 *(3.82)*	584.2 *(3.51)*	633.2 *(4.12)*
Ireland	**394.4 *(5.73)***	**449.6 *(4.44)***	**578.4 *(3.41)***	**630.2 *(4.64)***
Sweden	389.8 *(4.60)*	446.2 *(4.05)*	578.1 *(3.02)*	629.7 *(3.41)*
Czech Rep.	389.4 *(4.00)*	448.6 *(3.63)*	576.8 *(3.79)*	632.0 *(4.13)*
France	363.5 *(5.38)*	429.0 *(5.31)*	574.8 *(4.04)*	630.6 *(4.21)*
Norway	377.4 *(6.63)*	437.1 *(4.04)*	569.1 *(3.45)*	619.5 *(3.93)*
USA	367.6 *(10.00)*	430.2 *(9.59)*	571.2 *(7.97)*	628.0 *(6.98)*
Hungary	360.8 *(4.92)*	423.2 *(5.52)*	570.0 *(4.77)*	629.2 *(5.05)*
Iceland	380.7 *(4.30)*	436.0 *(3.66)*	557.5 *(3.06)*	606.7 *(4.07)*
Belgium	346.3 *(10.2)*	423.6 *(6.59)*	577.4 *(3.51)*	629.7 *(2.57)*
Switzerland	365.5 *(5.42)*	426.7 *(5.11)*	567.4 *(6.41)*	625.5 *(6.43)*
Spain	366.9 *(4.31)*	424.9 *(4.37)*	557.6 *(3.53)*	612.6 *(3.92)*
Germany	350.2 *(6.03)*	416.5 *(4.85)*	559.7 *(3.26)*	618.1 *(3.51)*
Poland	359.1 *(5.76)*	414.8 *(5.50)*	552.6 *(7.26)*	610.1 *(7.56)*
Denmark	346.6 *(5.32)*	410.3 *(4.81)*	554.1 *(3.50)*	612.5 *(4.36)*
Italy	348.8 *(6.16)*	410.8 *(4.4)*	547.1 *(3.51)*	602.1 *(4.02)*
Greece	334.1 *(8.34)*	392.9 *(6.95)*	530.0 *(5.29)*	585.2 *(5.34)*
Portugal	343.0 *(5.13)*	397.0 *(5.17)*	521.0 *(4.67)*	575.2 *(5.00)*
Luxembourg	319.7 *(6.79)*	382.3 *(3.43)*	509.9 *(2.75)*	563.2 *(4.44)*
Mexico	325.5 *(4.60)*	367.8 *(3.05)*	472.1 *(4.74)*	524.8 *(5.50)*
OECD Country Avg.	**368.5 *(1.03)***	**431.2 *(1.01)***	**571.8 *(0.84)***	**626.9 *(0.80)***

[*]Countries are ordered by overall achievement in scientific literacy.

COMPARING PERFORMANCE ACROSS ASSESSMENT DOMAINS

A relevant issue in interpreting the outcomes of PISA is the extent to which performance on the three assessment domains – reading literacy, mathematical literacy, and scientific literacy – is inter-related. In general, countries with high achievement in one PISA assessment domain (for example, combined reading literacy) have high achievement in all three domains. However, Ireland is an exception to this pattern since mean scores on combined reading literacy and scientific literacy are significantly higher than the OECD country average, but the mean score for mathematical literacy is not significantly different.

Further evidence for a strong association across the assessment domains comes from the consideration of the correlations between scores on combined reading literacy, mathematical literacy and scientific literacy. For example, the correlation between reading literacy and scientific literacy is .90, while that between reading literacy assessment and mathematical literacy for Irish students is .82. A correlation of .83 was obtained between mathematical literacy and scientific literacy (Table 3.11).[19]

Table 3.11. Correlations Among PISA Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scales, and Among the Three PISA Reading Subscales, for Irish Students

	C. Reading Literacy	*Mathematical Literacy*	*Scientific Literacy*
Combined Reading Literacy		.817	.896
Mathematical Literacy	.817		.833
Scientific Literacy	.896	.833	
	Retrieve	*Interpret*	*Reflect/ Evaluate*
Retrieve		.944	.900
Interpret	.944		.927
Reflect/Evaluate	.900	.927	

Note. Ns: Reading Literacy/Mathematical Literacy = 2128; Reading Literacy/Scientific Literacy = 2134; Mathematical Literacy/Scientific Literacy = 849.
All correlations are significant (p. < .001) (See Appendix 3, Table A3.1).

Not surprisingly, correlations among the three reading literacy subscales (Retrieving, Interpreting, and Reflecting/Evaluating) are uniformly high for Irish students, indicating that those who do well in one aspect are likely to do well in another.

A series of simple and multiple regressions for the overall scales were computed to examine in more detail relationships among combined reading literacy, mathematical literacy and scientific literacy. The proportion of variance[20] (r^2) in reading literacy explained by mathematical literacy is .67 (corresponding to an r value of .82 in Table 3.11). This proportion (R^2) increases to .82 when reading literacy is regressed on mathematical and scientific literacy combined (Table 3.12). Similarly, the proportion of variance in mathematical literacy explained by scientific literacy (.68) increases to .73 when mathematical literacy is regressed on reading literacy and scientific literacy combined.

[19] Correlation coefficients were estimated by combining the r^2s associated with pairs of plausible values for each assessment domain, following a procedure outlined in Appendix 4. Information on the interpretation of correlation coefficients can be found in Chapter 4 (Insets 4.4 and 4.5).
[20] Values of R^2s range from 0.0 to 1.0.

Table 3.12. Simple (r^2) and Multiple (R^2) Regressions for the Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scales (Irish Students)

Response Variables	*Explanatory Variables*					
	Reading L	*Mathematical L*	*Scientific L*	*Mathematical + Scientific L*	*Reading + Scientific L*	*Reading + Mathematical L*
Reading L		.668	.800	.824		
Mathematical L	.668		.694		.725	
Scientific L	.800	.694				.832

Note. Ns: Reading Literacy vs. Mathematical Literacy = 2128; Reading Literacy vs. Scientific Literacy = 2134; Mathematical Literacy vs. Scientific Literacy = 849. Multiple regressions = 849
All correlations are significant (p. < .001) (See Appendix 3, Table A3.2).

CONCLUSION

Irish students performed particularly well on the combined reading literacy scale, achieving an overall ranking of 5th among 27 OECD countries. Just one country, Finland, had a significantly higher mean score than Ireland. Performance across the three reading literacy subscales was also good, with the best performance coming on the Reflect/Evaluate subscale, where mean score differences among the top seven countries, including Ireland, are not statistically significant. Ireland's strong overall performance contrasts with the performance by Ireland's 14-year olds in the IEA reading literacy study some 10 years ago, when Ireland's mean score was close to that of the OECD median country, and Ireland ranked 16th of 19 OECD countries (see Chapter 2).

The strong overall performance of Irish students in reading literacy is reflected in the relatively large proportions of students scoring at the highest proficiency levels (Levels 4 and 5) on the combined reading literacy scales (41.3%), and the relatively low proportions scoring at Level 1 and below (11.0%). These percentages are quite different from those reported for Irish adults in the 16-65 age group on prose literacy in the International Adult Literacy Study (IALS), where just 13.5% were in the highest proficiency level (Levels 4 and 5 combined), and 22.6% at the lowest level (Level 1) (see Chapter 2). Ireland's performance on PISA also differs from that of Irish adults in the 16-25 years age group in IALS, where 15.2% achieved Levels 4/5 on prose literacy, and 15.9% achieved Level 1.

Differences in the proportions achieving at the highest and lowest levels of reading proficiency in the two studies may be due to a number of factors. First, as indicated in Inset 4.2, a response probability of .62 was used to construct the proficiency levels in PISA, whereas a more stringent response probability of .80 was used in IALS. Difference in the resultant cut points means that high proportions of students achieved higher levels of proficiency in PISA. Second, PISA assessed some aspects of reading literacy that were not assessed in IALS, including ability to reflect on and evaluate the content and structure of texts. It is quite possible that the inclusion of questions assessing these aspects of literacy favoured students in Ireland, and in other countries such as the United Kingdom, which also did relatively poorly in IALS but performed well in PISA. Another possible explanation for Ireland's relatively strong performance in PISA is examined in Chapter 6 of this report (i.e., links between the texts and tasks encountered by students in the reading literacy assessment and those encountered in the Junior Cycle programme in English in second-level schools).

While Irish students did relatively well on the PISA reading literacy assessment, it has to be acknowledged that 11.0% of Irish students (those scoring at or below Level 1) have relatively poor reading skills. This percentage is similar to the percentage of students in fifth class in primary schools who are deemed to have serious literacy difficulties (10%) (Cosgrove, Kellaghan, Forde & Morgan, 2000).

In considering the performance of Irish students on the PISA mathematical literacy tasks, it must be pointed out that only two aspects of mathematics were assessed, and that it is planned to assess a broader range of topics and processes when mathematics becomes a major assessment domain in 2003. Nevertheless, the performance of Irish students was poorer on mathematical literacy relative to their performance on reading and scientific literacy. They achieved a mean mathematical literacy score that was not significantly different from the OECD country average, and a ranking of 15th of 27 countries. This relatively poor performance in mathematics is underscored when one considers that Irish students achieve mean scores that are significantly higher than the OECD average in combined reading literacy and scientific literacy, whereas, in general, countries that do well in one assessment domain do well in all three. Elsewhere in this report, factors that may be related to Ireland's relatively poor performance in mathematics are considered, including variation in the use of calculators during the assessment (Chapter 4), and differences between PISA and the Junior Cycle mathematics curriculum as evidenced in syllabus documents and especially Junior Certificate Examination papers (Chapter 6).

Setting such issues aside for the present, it is clear that performance on PISA mathematical literacy is relatively poor when compared with the performance of Irish students in mathematics in the Third International Mathematics and Science Study (TIMSS). In TIMSS, eighth grade students in Australia, Austria, Canada, France, Switzerland, Sweden and New Zealand achieved mean scores that were not significantly different from Ireland's (Beaton et al., 1996a). However, in PISA, all of these countries had significantly higher mean scores than Ireland. It should be noted, however, that in TIMSS, Irish students in eighth grade (second year) performed relatively poorly in geometry, achieving a mean score of 43% correct, as against an international country average of 49%. Geometry has a stronger weighting in PISA 2000 (25.8% of items) than in TIMSS (15.0%).

The relatively strong performance of Australia on PISA mathematical literacy may relate to the strong emphasis that is placed on realistic mathematics in that country, while Hungary's relatively poor performance may be attributed to a strong emphasis on mathematical procedures, and a weak emphasis on problem solving, in that country. However, as PISA did not gather data about the mathematics curricula of participating countries, these observations, which arise from the TIMSS analysis of national contexts for mathematics education (Robitaille, 1997) are merely offered as hypotheses.

The relatively low score of Irish students at the 90th percentile in mathematical literacy is particularly striking. First, it is some 19 points below the OECD country average. Second, it is substantially lower than the corresponding scores of other countries with mean scores that are not significantly different from Ireland's. These observations, coupled with the fact that the scores of Irish students at the 10th and 25th percentiles compared favourably with the OECD country average scores at those markers, and with the scores of countries with mean scores similar to Ireland's, leads to the conclusion that the relatively poor performance of Ireland may, at least in part, be attributed to the poor performance of higher-achieving students.

The mean score of Irish students on scientific literacy was significantly higher than the OECD country average. Moreover, just six countries, including Korea, Japan and the United Kingdom, have significantly higher mean scores than Ireland. Nevertheless, five of the top six countries in scientific literacy have mean scores on reading literacy that are not significantly different from Ireland's. Hence, although Ireland's performance on scientific literacy is better than on mathematical literacy, it is poorer than on reading literacy. On the other hand, the performance of Irish 15-year olds on scientific literacy in PISA is somewhat better that that of Irish second year students in TIMSS, in that the latter group achieved a mean score in science that is not significantly different from the OECD country average. Countries such as Australia and Canada, whose eighth-grade students also achieved mean scores at the OECD average in TIMSS, have mean scores above the OECD average in PISA, while the Czech Republic, Austria and Hungary, whose eighth-grade students scored significantly above the OECD average in TIMSS achieved mean scores in PISA scientific literacy that are not significantly different from the OECD average. The strong performance of the United Kingdom in the PISA assessment of scientific literacy is interesting, given that students in England achieved a mean score in TIMSS science that was not significantly different from Ireland.

The scores for Irish students at the 10th and 90th percentiles are broadly in line with their overall performance on the test of scientific literacy. In subsequent chapters in this report, factors that may help to explain the performance of Irish students in scientific literacy are considered, including whether or not students studied science in the Junior Cycle (Chapter 4), and the extent to which the content and format of the PISA scientific literacy assessment overlaps with the Junior cycle programme and the Junior Certificate examination (Chapter 6).

The correlations among the scores of Irish students on the three assessment domains for Irish students are remarkably strong. The correlation of .90 between reading literacy and scientific literacy is particularly noteworthy, and may well reflect the strong reading/writing load that is common to the two assessments. Certainly, some of the processes in which students engaged in PISA reading literacy (for example, locating information in complex texts, critically evaluating information, making text-based inferences, and dealing with ambiguities and ideas contrary to expectations) seem likely to be drawn on in the tasks administered to students taking PISA's assessment of scientific literacy.

4

Correlates of Achievement in PISA

The purpose of this chapter is to describe relationships between a range of background variables and achievement in the three PISA assessment domains – reading literacy, mathematical literacy and scientific literacy. Variables are categorised according to whether they relate primarily to the student (e.g., home background, home educational climate, use of learning strategies, or reading habits and attitudes), or to the school (for example, school type, disciplinary climate, or availability of resources) (Inset 4.1). In general, student variables derive from students' responses to the Student questionnaire, while school variables are based on the responses of principal teachers to items on the School questionnaire (see Chapter 1), and have been disaggregated to the student level. In a number of cases, however, school variables (for example, negative disciplinary climate) are based on responses provided by students on the Student questionnaire. The chapter is divided into three sections. In the first, percentages and mean achievement scores associated with different levels of selected student characteristics are reported and compared. In the second section, the same analyses are reported for the school-level variables. In the third section, correlations between school and student variables and achievement in PISA are considered. While the primary focus of this chapter is on describing relationships between explanatory variables and the achievement of Irish students in PISA, reference is made at appropriate points to such relationships in other countries.

The analyses reported in this chapter examine associations between pairs of variables – a single explanatory variable and an achievement variable (for example, the association between an index of number of books in the home and combined reading literacy). Hence, causal relationships between the variables cannot be inferred. In Chapter 5, more complex multilevel analyses are presented. These seek to explain variance between and within schools by examining the simultaneous impact of a number of student and school variables on achievement. The particular variables selected for the analyses in this chapter and in Chapter 5 are based on a review of previous research (see Chapter 3) and on the priorities for analysis identified by the Irish National Advisory Committee for PISA.

Explanatory variables may be classified according to whether they are categorical or continuous. Categorical variables typically have two or more discrete categories (for example, male/female; very important/important/not important). Continuous variables describe a quantity (for example, the ratio of teachers to students in mathematics classes). Some continuous variables are composites based on two or more discrete variables. The composites were formed by first conducting a principal components analysis among several questionnaire items to identify those that might be included in the composite, and then applying a one-parameter (Rasch) item response theory model to generate weighted likelihood estimates (scores) on a scale with a mean of 0.0 and a standard deviation of 1.00 across all OECD countries. Examples of composite variables that were computed in this manner are attitude towards reading (based on 9 items on the Student Questionnaire) and student dropout risk (based on 8). A description of the questionnaire items associated with each explanatory variable is provided in Appendix 4 (Section 4.1) while the variables themselves are listed in Inset 4.1. The reader is referred to Insets 4.2 and 4.3 for a discussion of some of the technical issues that arose in performing the analyses reported in the chapter.

STUDENT CHARACTERISTICS AND ACHIEVEMENT

In this section, relationships between a range of student characteristics and achievement in PISA are considered. In most cases, the data are based on responses by students to questions on the School Questionnaire, which was administered to all students who participated in the assessment. Four categories of student characteristics are considered: student background, home educational climate, student as learner, and reading habits and attitudes.

Inset 4.1. Student and School Characteristics

Student Characteristics

Background

- Gender
- Chronological Age
- Socioeconomic Status
  - Mother's SES
  - Father's SES
  - Combined SES
- Parents' Education
  - Mother's Education
  - Father's Education
  - Combined Parents' Education
- Family Structure
  - Lone Parent Status
  - Number of Siblings

Home Educational Climate

- Parental Engagement
- Home Educational Resources
- Number of Books in the Home

Student as Learner

- Academic Orientation[**]
- Dropout Risk[**]
- Learning Support Classes – English
- Absence from School
- Homework and Study
  - Frequency of Homework and Study
  - Frequency of Homework Completed on Time
- Study of Science[*][**]
- Current Grade Level
- Level of Subjects Studied at Junior Cycle[**]
- Use of Calculators in PISA
- Learning Processes and Strategies

Student Characteristics (contd.)

Reading Habits and Attitudes

- Diversity of Reading[*]
- Frequency of Borrowing Library Books[*]
- Frequency of Leisure Reading[*]
- Attitude towards Reading[*]

School Characteristics

School Structure

- Stratum[**]
- Type[**]
- Management and Funding
- Disadvantaged Status[**]
- Gender Composition[**]

School Climate/Policy

- Negative Disciplinary Climate
- Negative Student Behaviour
- School Autonomy
- Frequency of Calculator Usage[*][**]

School Resources

- Student-Teacher Ratio
- Class Size
- Computer-Student Ratio

[*]Subject specific variable; [**]Variable based on data specific to Ireland.

Student Background

Patterns of achievement associated with five background variables – student gender, student chronological age, parents' socioeconomic status, parents' education, and family structure – are considered. Individual background variables are linked to achievement on combined reading literacy, mathematical literacy and scientific literacy. In the case of gender, achievement on the three literacy subscales – Retrieve, Interpret and Reflect/Evaluate – is also considered.

Inset 4.2. A Note on the Analyses

Weighting of responses. All percentages and mean achievement scores reported in this chapter are estimates that were computed using normalised population weights. The standard errors accompanying mean achievement scores were computed using a balanced repeated replication (BRR) method of variance estimation that took the PISA sample design into account (see Chapter 1).

Categorisation of continuous variables. For descriptive purposes, continuous variables (including composite variables constructed using weighted likelihood estimates) have been divided into 'high', 'medium' and 'low', using the 33rd and 67th percentiles as cut points. In some cases the percentage of students represented in a category does not correspond exactly to one third of available cases because of tied ranks at the designated cut points.

Treatment of missing values. Two columns of percentages are reported for each variable. The first of these (all cases) provides the percentage of cases at each level of the variable, and the percentage of missing cases. The second (available cases) distributes cases over the different levels of the variable, and does not include missing cases. When percentages are discussed in the text, they refer to the second column (i.e., to available cases). For most variables, the percentage of missing values is less than 5. Variables for which this percentage exceeds 5 are discussed in the text, and consideration is given as to whether the achievement of students for whom data were not available is statistically significantly different from that of students in an appropriate reference category for whom data were available.

Testing for the statistical significance of mean score differences. Tests designed to ascertain the significance of differences between mean achievement scores associated with different levels of each explanatory variable were conducted. The approach used to assess the significance of differences between mean scores necessitated the selection of an appropriate reference category for each variable. For continuous variables, the middle group (the middle third in the case of continuous composite variables) was usually selected. Comparisons were then made between the mean score of the reference category and the mean score of each remaining group, including, where relevant, the missing value category. This involved examining the statistical significance of the difference between each pair of mean scores.

To reduce the possibility of making a Type 1 error (i.e., incorrectly inferring a significant difference between means) in the context of multiple comparisons, Bonferroni's procedure was applied and appropriately adjusted critical (t) values corresponding to the .05 and .10 levels were obtained (see Appendix 4, Section 4.3,). Then, confidence intervals were constructed by adding to and subtracting from each mean score difference the product of the corresponding standard error of the difference and the adjusted critical value. Although not reported in the tables in this chapter, 90% confidence intervals were constructed to identify any differences which, though not significant at the conventional .05 level, might be significant at the .10 level. Such differences are reported if they are significant, since they may be worthy of further exploration through future research. It can be concluded that a difference is statistically significant if a value of zero (0) does not fall within the relevant confidence interval.

Testing for the statistical significance of the difference between percentages. A similar approach to that used to test the significance of mean score differences was used to test significance of the difference between pairs of percentages (for example, the percentages of male and female students at a particular proficiency level on the combined reading scale). The large-sample Normal sampling distribution (rather than the t distribution) was used to obtain the 90% and 95% confidence intervals, as this avoids the complexities involved in calculating the degrees of freedom corresponding to values of t (Agresti & Finlay, 1997, pp. 219-222).

Student Gender

The mean combined reading literacy score of Irish females students is some 28.7 score points higher than for Irish male students (Table 4.1). This difference is statistically significant at the .05 level (Inset 4.3). Male students achieved a significantly higher mean score than female students in mathematical literacy, though the difference (12.9 score points) is relatively small. The difference between the mean scores of males and females on scientific literacy (6.2 score points in favour of females) is not statistically significant.

Table 4.1. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, by Gender

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Student Gender												
Male	49.2	49.6	512.8	4.18	48.5	48.9	510.1	4.02	49.5	49.9	510.7	4.23
Female	50.1	50.4	541.5	3.55	50.7	51.1	497.3	3.42	49.8	50.1	516.9	4.17
Missing	0.7	0.0	438.1	15.14	0.8	0.0	426.0	16.41	0.7	0.0	447.4	23.41
All Available	99.3	100.0	526.7	3.24	99.2	100.0	502.9	2.72	99.3	100.0	513.4	3.18
Mean Score Differences (Reference Category: Female)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Male–Fem	–28.7	5.50	**–41.2**	**–16.1**	12.9	5.30	**0.8**	**24.9**	–6.2	5.90	–19.8	7.4
Missing–Fem	–103.4	15.60	**–139.0**	**–67.9**	–71.3	16.80	**–109.6**	**–33.0**	–69.5	23.80	**–123.8**	**–15.2**

Note. N (Combined Reading Literacy) = 3854; N (Mathematical Literacy) = 2128; N (Scientific Literacy) = 2134; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Female students achieved significantly higher scores than their male counterparts in all OECD[21] countries on combined reading literacy, with an OECD mean difference of –29 scale score points (Appendix 4, Table A4.1). Differences ranged from –51 points (Finland) to –14 (Korea). The difference between Irish males and females is at the OECD mean. The very large difference in favour of females in Finland is interesting in the context of that country's high mean score in combined reading literacy. In mathematical literacy, in half of the OECD countries, male students achieved significantly higher scores than females. However, the OECD mean difference of 11 points was about one-third that for combined reading literacy. The difference of 13 points between Irish male and female students is just above this mean figure. Across all countries, differences ranged from –5 (SE = 4.0) in Iceland (where females achieved a higher though not statistically significant mean score than males) to 27 in Korea (where males did significantly better). In scientific literacy, no clear pattern of gender differences emerged across countries, with significant differences in favour of males in four countries, including Korea, and no significant differences favouring females. Differences ranged from –12 (New Zealand, where female students did better) to 19 (Korea). The average difference across OECD countries was 0 (i.e., country differences between male and female students cancelled themselves out).

Following the finding of a significant difference in mean achievement in favour of female students on the combined reading literacy scale, the performance of male and female students on the three reading literacy subscales was compared. Irish female students outperformed male students by 22.3 points on the Retrieve subscale, 27.2 points on the Interpret subscale, and 37.2 points on the Reflect/Evaluate subscale (Table 4.2). All three differences are statistically significant at the .05 level.

[21] Gender differences were not computed for the Netherlands, which did not meet PISA criteria in relation to the participation of schools.

Inset 4.3. Identifying a Significant Difference Between Mean Achievement Scores

Throughout this chapter, reference is made to differences between mean achievement scores. As indicated in Inset 4.2, the approach taken to examining whether or not a difference between mean scores is significant involved computing the standard error of the difference, identifying the relevant critical values (*t* scores) adjusted for multiple comparisons, and constructing 95% and 90% confidence intervals around the difference. An example of how differences between mean scores may be interpreted is provided here.

	2-tailed Alpha (Probability) Per Comparison	*Adjusted t value*
95%	.025	2.284
90%	.050	1.990

Mean Score Differences for Combined Reading Literacy (Reference Category: Females)

	Diff	*SED*	*BCI95%*		*BCI90%*	
Male–Female	–28.7	5.49	**–41.2**	**–16.2**	**–39.6**	**–17.8**
Missing–Female	–103.4	15.55	**–139.0**	**–67.9**	**–134.4**	**–72.5**

Note. Diff = Mean Achievement Difference; SED = Standard Error of the Difference; BCI95% = Bonferroni Adjusted 95% Confidence Interval; BCI90%: Bonferroni Adjusted 90% Confidence Interval

In this example, the alpha levels corresponding to the 95% and 90% confidence intervals (i.e., .05 and .10) were each divided by the number of comparisons to be made (2), and critical values corresponding to these alpha (probability) levels were obtained from a table of critical values of *t*, using an approximation of 80 degrees of freedom [the number of variance strata associated with balanced repeated replicate (BRR) method of variance estimation]. The difference between the mean scores for males and females is –28.7 (see Table 4.1). The negative difference arises from the fact that 'female' was selected as the reference category for the purpose of comparing groups. In this example, the 95% confidence interval was obtained by subtracting 12.52 (i.e., 2.284 x 5.49) from, and adding it to, –28.7. Since 0 is outside the resulting confidence interval (–41.2, –16.2), it can be concluded (with 95% confidence) that there is a statistically significant difference between the mean combined reading literacy scores of males and females. Significant differences are indicated in bold in the tables in which they arise throughout the chapter.

It was not possible to classify 0.07% of students by gender (see Table 4.1). The difference between the mean combined reading literacy score of these students, and of students in the reference category (i.e., females) is statistically significant at the .05 level. Such a difference would be of interest in cases in which a large percentage (more than 5%) of students are missing (i.e., students for whom achievement test scores were available who did not respond to a particular questionnaire item or set of items).

Across all countries, gender differences tend to be largest on the Reflect/Evaluate subscale, with an OECD mean of –40 points. The mean differences for the Retrieve and Interpret subscales were –23 and –26 points respectively (Appendix 4, Table A4.2). Hence, the differences between Irish male and female students on the three reading literacy subscales are close to the corresponding OECD mean differences. The largest difference between male and female students across all three subscales occurs in the case of Finland, where female students achieved a mean score of 563.7 on the Reflect/Evaluate scale – some 63 points more than their male counterparts.

Table 4.2. Mean Scores of Irish Students on the Retrieve, Interpret, and Reflect/Evaluate Reading Literacy Subscales, by Gender

	Retrieve				*Interpret*				*Reflect/Evaluate*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Student Gender												
Male	49.2	49.6	513.6	4.24	49.2	49.6	513.4	4.34	49.2	49.6	515.1	3.99
Female	50.1	50.4	536.0	3.63	50.1	50.4	540.5	3.61	50.1	50.4	552.3	3.31
Missing	0.7	0.0	444.4	16.26	0.7	0.0	444.5	15.82	0.7	0.0	439.2	15.46
All Available	99.3	100.0	524.3	3.25	99.3	100.0	526.5	3.29	99.3	100.0	533.2	3.10
Mean Score Differences (Reference Category: Female)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Male–Fem	–22.3	5.60	**–35.1**	**–9.6**	–27.2	5.60	**–40.1**	**–14.3**	–37.2	5.20	**–49.1**	**–25.4**
Missing–Fem	–91.5	16.70	**–129.6**	**–53.5**	–96.1	16.20	**–133.1**	**–59.0**	–113.1	15.80	**–149.2**	**–77.0**

Note. N (Retrieve) = 3854; N (Interpret) = 3854; N (Reflect) = 3854. %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Gender differences in reading literacy can also be examined in terms of the proportions of males and females at each proficiency level on the combined reading scale and on the three subscales. As indicated in Chapter 4, each proficiency level represents a range of skills, and students within a particular level are expected to get 50% of the items at that level correct. In general, proportionately more male students were represented at the lower proficiency levels on the combined reading literacy scale, while more females were represented at the upper levels. Exactly 4.0% of Irish male students, and 2.0% of female students, achieved below Level 1 on this scale (Table 4.3). While the difference between the percentages of males and females achieving below level 1 is not statistically significant at the conventional .05 level,[22] it does reach significance at the .10 level (Bonferroni 90% Confidence Interval: 0.06, 3.92). Proportionately more male (13.5%) than female (8.3%) students achieved at or below Level 1. On the other hand, a significantly greater percentage of female students (17.4%) than of male (11.2%) students achieved Level 5, the highest reading literacy proficiency level.

Differences were also found between the proportions of Irish male and female students achieving each proficiency level on the reading literacy subscales (Appendix 4, Tables A4.3, A4.4, and A4.5). The most notable differences occurred on the Reflect/Evaluate subscale, where significantly higher percentages of males than of females are below Level 1 and at Levels 1 and 2, and significantly higher percentages of females are at Levels 4 and 5 (Appendix 4, Table A4.5).

Since proficiency levels were not computed for either mathematical or scientific literacy, the performances of male and female students were examined from two perspectives: (i) the proportions of males and females at each of four selected intervals on the distributions of achievement for Irish students using national cut points (at or below the 10th percentile; between the 11th and 50th percentiles; between the 51st and 89th percentiles, and at or above the 90th percentile); and (ii) the scores of males and females at five key national markers (the Irish 10th, 25th, 50th, 75th and 90th percentiles). The performance of students at the 10th percentile is of particular interest in the Irish context, since it is sometimes used as a criterion point to identify students in need of learning support or other interventions.

[22] Where a percentage in a table cell is outside the range of 10-90% (i.e., below Level 1 and at Level 1 in Table 4.3), additional care should be exercised in interpreting differences between percentages (Agresti & Finlay, 1997).

In mathematical literacy, 9.1% of male students and 10.4% of female students achieved scores that were at or below the 10th percentile (Table 4.4), while 11.9% of males and 7.9% of females achieved scores at or above the 90th percentile. Neither these differences, nor ones between proportions of males and females achieving scores between the 11th and 50th percentiles, or between the 51st and 89th percentiles, are significant at the .05 level. However, the difference in the proportion of males and females achieving scores at or above the 90th percentile reached statistical significance at the .10 level (Bonferroni 90% Confidence Interval: 0.08, 8.03). Hence, while almost equal proportions of male and female students are represented at the lower end of the mathematical literacy scale, the data suggest that more males than females are represented at the higher end.

Table 4.3. Percentages of Irish Students at Each Combined Reading Literacy Proficiency Level, and Percentage Differences, by Gender

Level	*Males*		*Females*		*All Available*	
	Percent	*SE*	*Percent*	*SE*	*Percent*	*SE*
<1	4.0	0.64	2.0	0.49	3.0	0.44
1	9.5	1.05	6.3	0.96	7.9	0.82
2	21.3	1.49	14.3	0.97	17.8	0.91
3	29.9	1.54	29.6	1.31	29.7	1.11
4	24.1	1.45	30.4	1.36	27.3	1.10
5	11.2	1.10	17.4	1.18	14.3	0.84
Percentage Differences (Reference Category: Female)						
	Difference	*SED*	*BCI95%*			
<1	1.99	0.81	–0.1	4.1		
1	3.24	1.42	–0.5	7.0		
2	7.02	1.77	**2.3**	**11.7**		
3	0.32	2.02	–5.0	5.6		
4	–6.37	1.99	**–11.6**	**–1.1**		
5	–6.21	1.61	**–10.5**	**–2.0**		

Note. Information on gender was unavailable for 25 students. Hence, the percentages in this table are based on a sample of 3829 students (1841 males, and 1988 females). Difference: Difference between percentages; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Table 4.4. Percentages of Irish Students at Four Key Score Intervals in Mathematical Literacy, and Percentage Differences, by Gender

Percentiles	*Males*		*Females*		*All Available*	
	Percent	*SE*	*Percent*	*SE*	*Percent*	*SE*
≤10th	9.1	1.09	10.4	1.16	9.8	0.83
11th–50th	37.9	2.17	42.3	1.43	40.1	1.23
51st–89th	41.1	1.77	39.5	1.65	40.3	1.21
≥90th	11.9	1.46	7.9	1.00	9.8	0.92
Percentage Differences (Reference Category: Female)						
	Difference	*SED*	*BCI95%*			
≤10th	–1.26	1.59	–5.2	2.7		
11th–50th	–4.45	2.60	–10.9	2.1		
51st–89th	1.66	2.42	–4.4	7.7		
≥90th	4.05	1.77	–0.4	8.5		

Note. Information on gender was unavailable for 17 Irish students who completed the PISA mathematical literacy assessment. Hence, N = 2111 (1006 males and 1105 females). Column totals may be different due to rounding. Difference: Difference between percentages; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.
Percentages do not sum to 100 due to rounding.

The mean mathematical achievement score of male students scoring at the 10th percentile is 398.5, while the corresponding score for female students is 392.3 (Table 4.5). The difference (6.2 scale points) is not statistically significant. However, the difference between male and female students at the 75th percentile (17.5 points) is statistically significant at the .05 level, while the difference at the 90th percentile (17.0 points) is significant at the .10 level (Bonferroni 90% Confidence Interval: 0.54, 33.03). Hence, in addition to being proportionally better represented at the higher levels of achievement in mathematical literacy, male students at these levels also tend to have higher literacy scores.

Table 4.5. Mean Mathematical Literacy Scores of Irish Students at Five Key Markers, and Mean Score Differences, by Gender

	Males		*Females*		*All Available*	
Percentiles	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
10	398.5	6.62	392.3	6.98	395.1	4.95
25	455.7	5.79	445.6	4.52	450.1	3.66
50	515.0	5.20	502.9	3.87	509.1	3.14
75	571.0	5.02	553.5	4.21	561.5	3.54
90	613.8	4.34	596.8	5.43	606.4	4.16

Percentage Differences (Reference Category: Female)

	Difference	*SED*	*BCI95%*	
10	6.2	9.62	–19.2	31.6
25	10.1	7.35	–9.3	29.5
50	12.1	6.48	–5.0	29.2
75	17.5	6.55	**0.2**	**34.8**
90	17.0	6.95	–1.3	35.4

Note. Information on gender was unavailable for 17 Irish students who completed the PISA mathematical literacy assessment. Hence, N = 2111 (1006 males and 1105 females). Column totals may differ slightly due to rounding Difference: Difference between mean scores; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

In the scientific literacy assessment, 11.0% of male and 8.7% of female students in Ireland achieved scores that are at or below the 10th percentile (Table 4.6). However, neither the difference between the percentages of males and females in this interval, or in the other three intervals under consideration, is statistically significant at either the .05 or .10 level.

Table 4.6. Percentages of Irish Students at Four Key Score Intervals in Scientific Literacy, and Percentage Differences, by Gender

	Males		*Females*		*All Available*	
Percentiles	*Percent*	*SE*	*Percent*	*SE*	*Percent*	*SE*
≤10th	11.0	1.3	8.7	1.14	9.8	0.90
11th–50th	40.7	2.0	39.4	2.00	40.1	1.27
51st–89th	38.1	1.8	42.0	1.78	40.1	1.31
≥90th	10.2	1.2	9.9	1.14	10.0	0.77

Percentage Differences (Reference Category: Female)

	Difference	*SED*	*BCI95%*	
≤10th	2.3	1.71	–2.0	6.5
11th–50th	1.4	2.80	–5.6	8.4
51st–89th	–3.9	2.55	–10.2	2.5
≥90th	0.2	1.67	–3.9	4.4

Note. Information on gender was unavailable for 13 students who completed the PISA assessment of scientific literacy. Hence, percentages are based on a sample of 2121 students (1023 males and 1098 females). Difference: Difference between percentages; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Although differences in the order of 13.4 and 12.8 score points in favour of female students were observed on the scientific literacy scale at the 10th and 25th percentiles, neither these nor the other observed differences reaches statistical significance (Table 4.7). This is broadly in line with the finding reported earlier in this chapter that the mean scientific literacy scores of male and female students are not statistically significantly different.

Table 4.7. Mean Scientific Literacy Scores of Irish Students at Five Key Markers, and Mean Score Differences, by Gender

	Males		*Females*		*All Available*	
Percentiles	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
10	388.2	7.70	401.6	7.28	395.2	5.65
25	443.5	4.96	456.4	5.59	449.9	4.46
50	510.9	5.74	519.9	5.13	515.3	4.07
75	578.2	4.90	578.8	4.49	578.6	3.66
90	631.1	6.48	629.2	5.39	630.4	3.90

Percentage Differences (Reference Category: Female)

	Difference	*SED*	*BCI95%*	
10	–13.4	10.60	–41.3	14.6
25	–12.8	7.47	–32.5	6.9
50	–9.0	7.69	–29.4	11.3
75	–0.6	6.96	–19.0	17.7
90	1.9	8.43	–20.4	24.1

Note. Information on gender was unavailable for 13 students who completed the PISA assessment of scientific literacy. Hence, percentages are based on a sample of 2121 students (1023 males and 1098 females). Difference: Difference between mean scores; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Chronological Age of Students

All Irish students participating in PISA were born between January 1 and December 31, 1984. Their average age was 188.4 months (SE = 0.06).[23] This is equivalent to 15 years and 8 months. For descriptive purposes, the distribution of ages for Irish students was divided into the three categories, older, average, and younger (using the 33rd and 67th percentile ranks as cut points), and the achievement of students in these categories was compared. Although older students achieved slightly higher mean scores in combined reading literacy, mathematical literacy and scientific literacy than their average-aged counterparts, and average-aged students achieved higher mean scores than younger students, the differences are not statistically significant (Table 4.8).

Table 4.8. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Chronological Age (Months)

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Age												
Older	39.2	39.5	535.3	3.67	30.4	30.7	508.0	4.41	31.6	31.8	521.0	4.14
Average	26.4	26.6	526.7	4.09	35.4	35.7	503.1	3.85	32.8	33.0	515.5	4.50
Younger	33.7	33.9	518.5	4.31	33.4	33.7	500.1	4.09	35.0	35.2	505.8	4.60
Missing	0.7	0.0	438.1	15.14	0.8	0.0	426.0	16.41	0.7	0.0	447.4	23.41
All Available	99.3	100.0	526.7	3.24	99.2	100.0	502.9	2.72	99.4	100.0	513.4	3.18

[23] This definition of 15-year olds relates to the time of the year at which the PISA assessment was administered in Ireland.

Table 4.8. Continued

Mean Score Differences (Reference Category: Average)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Old–Avg	8.6	5.49	–4.8	22.0	5.0	5.85	–9.4	19.3	5.5	6.12	–9.4	20.5
Young–Avg	–8.1	5.94	–22.6	6.4	–3.0	5.62	–16.7	10.7	–9.7	6.44	–25.4	6.1
Missing–Avg	–88.6	15.68	**–126.9**	**–50.2**	–77.1	16.85	**–118.3**	**–35.9**	–68.0	23.83	**–126.3**	**–9.7**

Note. N (Retrieve) = 3854; N (Interpret) = 3854; N (Reflect) = 3854; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Parents' Socioeconomic Status

Students were asked to indicate their mother's and father's main occupations, and what each parent did in their main occupation. Their responses were categorised according to the International Standard Classification of Occupation (ISCO) system. The resulting ISCO categories were then transformed into an International Socioeconomic Index (ISEI) according to a methodology developed by Ganzeboom, de Graaf and Treiman (1992) and Ganzeboom and Treiman (1996), to yield the variables, mother's socioeconomic status and father's socioeconomic status.[24]

One category of occupation not accounted for by ISEI is that of homemaker. In the case of mother's socioeconomic status (Table 4.9), homemaker is identified as a separate category, while the remaining non-missing students are categorised as having high, medium, or low levels of socioeconomic status, based on their scores on the ISEI scale (the 33rd and 67th percentile ranks were used as cut points). In the case of father's socioeconomic status (Table 4.10), just two fathers were identified as homemakers, and these were classified as missing since there were too few cases to generate achievement estimates for a homemaker category.

Table 4.9. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Mother's Socioeconomic Status

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Mother's SES (SES-MO)												
High	25.6	28.0	556.5	3.78	24.8	27.1	527.3	3.94	26.9	29.3	544.9	4.49
Medium	28.0	30.5	541.9	3.88	28.7	31.4	514.3	3.93	26.8	29.2	528.6	5.08
Low	28.1	30.7	501.3	4.21	27.3	29.8	478.4	3.96	28.5	31.0	489.0	4.49
Homemaker	10.0	10.9	516.3	5.42	10.7	11.7	500.1	5.93	9.7	10.6	494.2	6.92
Missing	8.4	0.0	482.6	7.46	8.6	0.0	475.9	7.20	8.1	0.0	466.3	7.88
All Available	92.0	100.0	526.7	3.24	91.5	100.0	502.9	2.72	92	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students with Medium-SES Mothers)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Med	14.6	5.42	**0.8**	**28.5**	13.0	5.56	–1.2	27.2	16.3	6.78	–1.0	33.6
Low–Med	–40.6	5.73	**–55.2**	**–26.0**	–35.9	5.58	**–50.2**	**–21.6**	–39.6	6.78	**–56.9**	**–22.2**
Home–Med	–25.5	6.66	**–42.5**	**–8.5**	–14.2	7.11	–32.3	4.0	–34.4	8.58	**–56.3**	**–12.5**
Missing–Med	–59.2	8.41	**–80.7**	**–37.7**	–38.4	8.20	**–59.4**	**–17.4**	–62.3	9.37	**–86.2**	**–38.4**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134. Socioeconomic status was categorised according to the International Socioeconomic Index (ISEI). %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

[24] Ganzeboom and colleagues argue that occupations can best be scaled using their role as intermediaries between education and income. While ISEI is a simple mapping from each ISCO code, like other procedures used to derive SEI scores for occupations, ISEI can also be interpreted as a weighted average of educational requirements and mean incomes associated with detailed occupations.

The mean combined reading literacy score of students with high-SES mothers (556.5 points) is statistically significantly higher than that of students with medium-SES mothers (541.9) (Table 4.9). The mean combined reading literacy score of students with medium-SES mothers is, in turn, significantly higher that of students with low SES-mothers. Interestingly, the mean score achieved by students in the latter category (501.3) was just above the OECD mean of 500. Whereas the difference between the mean scores of students with high-SES and medium-SES mothers is just 14.6 points, that between students with medium- and low-SES mothers is some 40.6 points. There is a statistically significant difference between the mean combined reading literacy scores of students whose mothers are homemakers and students of medium-SES mothers, with students of medium-SES mothers achieving the higher score.

The differences between the mean mathematical literacy scores of students with high- and medium-SES mothers is 13.0 score points, and does not reach statistical significance at the .05 level (Table 4.9). However, the difference is significant at the .10 level (Bonferroni 90% Confidence Interval: 0.3, 25.7). The difference between these groups in scientific literacy is not statistically significant at either the .05 or .10 levels. The difference between mean mathematical literacy scores of students with medium- and low-SES mothers (35.9 score points) is statistically significant, favouring students with medium-SES mothers. In scientific literacy, a significant difference of 39.6 points also favours students with medium-SES mothers over students with low-SES mothers. The differences in mean achievement scores between students with mothers categorised as medium-SES and students whose mothers are homemakers are statistically significant for all three assessment domains, and favour students with medium-SES mothers.

Differences also emerged between the mean achievement scores of students whose fathers were categorised by socioeconomic status (Table 4.10).

Table 4.10. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Father's Socioeconomic Status

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Father's SES												
High	33.3	36.5	558.6	3.68	31.1	34.1	533.2	4.30	34.0	37.3	540.4	4.38
Medium	26.6	29.1	520.0	3.80	26.7	29.3	499.8	3.80	25.9	28.4	509.7	4.15
Low	31.4	34.4	510.5	4.13	33.3	36.5	487.7	3.59	31.4	34.4	498.1	4.73
Missing	8.7	0.0	483.7	6.21	8.8	0.0	463.0	7.46	8.7	0.0	473.5	6.93
All Available	91.3	100.0	526.7	3.24	91.1	100.0	502.9	2.72	91.3	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students with Medium-SES Fathers)												
	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High-Med	38.6	5.29	**25.7**	**51.5**	33.4	5.74	**19.4**	**47.5**	30.7	6.03	**16.0**	**45.4**
Low-Med	–9.5	5.61	–23.2	4.2	–12.0	5.23	–24.8	0.7	–11.7	6.29	–27.0	3.7
Missing-Med	–36.3	7.28	**–54.0**	**–18.5**	–36.8	8.37	**–57.2**	**–16.3**	–36.3	8.08	**–56.0**	**–16.5**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134. Socioeconomic status, categorized according to the International Socioeconomic Index (ISEI). %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

The differences between the mean reading literacy, mathematical literacy and scientific literacy scores of students with high- and medium-SES fathers are all significant at the .05 level, and favour students with high-SES fathers in all cases. Whereas mean score differences between students with medium- and low-SES fathers are not statistically significant at either the .05 or .10 levels for reading literacy and scientific literacy, the difference between students in these categories on mathematical literacy is significant at the .10 level (Bonferroni 90% Confidence Interval: –23.3, –0.7). While achievement differences between students with high- and medium-SES mothers are relatively small (13 to 16 points), those between students with high- and medium-SES fathers are quite large (31 to 39 points, or about one third of a standard deviation[25]).

A measure of combined parents' socioeconomic status was constructed by identifying and coding the highest level of SES of each student's mother and father, using the ISCO system.[26] The resulting distribution of SES scores was divided into thirds for descriptive purposes. High SES students (i.e., students with at least one parent in a high SES category) achieved a mean score of 558.2 on combined reading literacy, while students categorised as medium and low SES achieved scores of 529.0 and 492.5 respectively (Table 4.11). The differences between the mean combined reading literacy scores of high- and medium-SES students, and between medium- and low-SES students are statistically significant at the .05 level. Similar findings emerged when the mean mathematical literacy and scientific literacy scores of high- and medium-SES students, and of medium- and low-SES students, are compared. Differences between high- and medium-SES students are in the region of one quarter of a standard deviation, while those between medium- and low-SES students are in the region of one third of a standard deviation.

Table 4.11. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Combined Parents' Socioeconomic Status

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Parents' SES												
High	38.1	39.4	558.2	3.31	37.2	38.5	528.4	3.86	39.0	40.3	543.5	3.68
Medium	28.0	29.0	529.0	3.59	28.5	29.5	507.6	3.14	27.7	28.5	515.0	4.11
Low	30.7	31.7	492.5	4.02	30.9	32.0	474.0	3.80	30.3	31.2	479.7	4.28
Missing	3.2	0.0	458.5	9.65	3.4	0.0	448.0	11.67	3.1	0.0	448.9	10.51
All Available	96.8	100.0	526.7	3.24	96.6	100.0	502.9	2.72	97.0	100.0	513.4	3.18
Mean Score Differences (Reference Category: Medium-SES Students)												
	Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Med	29.1	4.88	**17.2**	**41.1**	20.8	4.98	**8.6**	**33.0**	28.5	5.52	**15.0**	**42.0**
Low–Med	–36.5	5.39	**–49.7**	**–23.4**	–33.7	4.93	**–45.7**	**–21.6**	–35.3	5.93	**–49.8**	**–20.8**
Missing–Med	–70.6	10.29	**–95.7**	**–45.4**	–59.7	12.08	**–89.2**	**–30.1**	–66.1	11.28	**–93.7**	**–38.5**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134. Socioeconomic status, categorised according to the International Socioeconomic Index (ISEI). %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Parents' Level of Education

Students responding to the Student questionnaire were asked to indicate the highest level of formal education completed by their parents. Responses were coded according to whether a student's parent (1) received no education or completed primary education only; (2) completed lower second level (junior cycle); (3) completed upper second level (senior cycle); or (4) completed tertiary education. This classification is broadly in line with the International Standard Classification of Education (ISCED) (OECD, 1999a) (see Appendix 4, Section 4.2).

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[25] Standard deviations for Irish students in PISA are 93.59 for combined reading literacy, 83.59 for mathematical literacy, and 91.77 for scientific literacy (See Table 3.1, Chapter 3).

[26] In line with ISCO, in cases where mother was a homemaker, the father' occupation (if available) was used in computing an index of combined parents' SES. Otherwise, combined SES was recorded as 'unemployed' and treated as missing in analyses.

Just over 16% of students who participated in the PISA reading literacy assessment indicated that the highest level of education completed by their mothers was primary. A quarter indicated lower secondary, 32% upper secondary, and almost a quarter third level (Table 4.12). Students of mothers who had completed a third level course achieved significantly higher mean scores on combined reading literacy and scientific literacy than students of mothers who had completed second-level education only. However, the difference between mean scores in mathematical literacy for students in these categories did not reach statistical significance. Students whose mothers had completed upper second-level schooling achieved significantly higher mean scores in all three PISA assessment domains than students whose mothers had lower educational attainments.

Table 4.12. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Mother's Level of Education

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Mother's Education (Level)												
None/Primary	16.4	16.6	496.6	5.52	16.5	16.8	472.3	5.83	16.4	16.6	481.4	5.49
Lower Second	25.5	25.8	517.6	3.30	25.4	25.8	490.9	3.72	25.7	26.1	498.5	4.02
Upper Second	30.8	32.2	535.7	3.73	30.8	31.3	516.0	3.68	30.3	30.7	522.4	4.26
Third Level	24.2	24.5	551.6	4.90	24.2	24.6	524.7	4.57	24.2	24.6	544.4	5.53
Missing	3.2	0.0	476.8	10.65	3.1	0.0	463.6	13.02	3.3	0.0	477.9	11.42
All Available	98.8	100.0	526.7	3.24	98.4	100.0	502.9	2.72	98.6	100.0	513.4	3.18
Mean Score Differences (Reference Category: Upper Second Level)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
N/Prim–Up Sec	–39.1	6.66	**–56.1**	**–22.1**	–43.7	6.89	**–61.3**	**–26.1**	–41.0	6.95	**–58.7**	**–23.2**
Lwr 2nd–Up Sec	–18.1	4.98	**–30.8**	**–5.4**	–25.1	5.23	**–38.4**	**–11.7**	–23.8	5.86	**–38.8**	**–8.9**
3rd Lev.–Up Sec	15.9	6.16	**0.1**	**31.6**	8.6	5.86	–6.3	23.6	22.1	6.98	**4.2**	**39.9**
Missing–Up Sec	–59.0	11.29	**–87.8**	**–30.1**	–52.4	13.53	**–87.0**	**–17.9**	–44.5	12.19	**–75.6**	**–13.4**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

The fathers of approximately one in four students who participated in the PISA reading literacy assessment had completed a third-level course, while a similar number had attained no higher than a primary education (Table 4.13).

Table 4.13. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Father's Level of Education

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Father's Education Level												
None/Primary	24.6	25.5	508.3	4.54	24.5	25.4	483.9	4.50	25.2	26.2	490.9	4.84
Lower Second	26.7	27.7	520.4	3.61	27.7	28.7	493.4	4.37	26.4	27.5	508.3	4.56
Upper Second	21.0	21.8	538.8	4.08	20.8	21.5	519.3	4.78	21.3	22.2	521.1	4.56
Third Level	22.5	23.3	551.3	4.46	21.7	22.5	529.2	4.51	21.6	22.4	545.5	5.70
Missing	5.2	0.0	490.5	8.93	5.2	0.0	467.8	7.35	5.6	0.0	485.0	10.26
All Available	96.5	100.0	526.7	3.24	96.4	100.0	502.9	2.72	96.3	100.0	513.4	3.18
Mean Score Differences (Reference Category: Upper Second Level)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
N/Prim–Up Sec	–30.5	6.11	**–46.1**	**–14.9**	–35.4	6.57	**–52.1**	**–18.6**	–30.2	6.65	**–47.2**	**–13.2**
Lwr Sec–Up Sec	–18.4	5.44	**–32.3**	**–4.4**	–25.9	6.48	**–42.4**	**–9.3**	–12.7	6.45	–29.2	3.7
3rd Lev–Up Sec	12.5	6.04	–2.9	28.0	9.9	6.57	–6.9	26.7	24.4	7.30	**5.7**	**43.0**
Missing–Up Sec	–48.2	9.82	**–73.3**	**–23.1**	–51.6	8.77	**–74.0**	**–29.1**	–36.0	11.23	**–64.7**	**–7.3**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

The differences in mean achievement scores between students whose fathers had completed a third-level course and those whose fathers had completed upper second level only were statistically significant in the case of scientific literacy, but not in the case of combined reading literacy or mathematical literacy. On the other hand, students whose fathers had completed upper second-level schooling achieved significantly higher mean overall reading literacy and mathematical literacy scores than students whose fathers had completed lower second-level schooling, but the difference between the mean scientific literacy scores of students in these categories does not reach statistical significance.

A combined measure of parents' education was obtained by taking the highest level of education attained by a student's mother or father. Data were missing for just 1.8% of students. In the case of 35.6% of students, at least one parent had completed a third-level degree or diploma course, while, in the case of 11.8% of students, neither parent had completed a higher level than primary education (Table 4.14). The mean combined reading literacy, mathematical literacy and scientific literacy scores of students with at least one parent who had completed a third-level course were significantly higher than those of students of parents whose combined highest level of education was upper second level. Similarly, students with parents whose combined highest educational level was upper second level had significantly higher mean scores in the three assessment domains than students of parents whose combined highest level was lower secondary. The largest achievement differences (about one third of a standard deviation in each domain) were observed between students of parents whose combined highest educational level was an upper second-level education and students of parents whose combined level was, at most, a primary level education.

Table 4.14. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Parents' Highest Level of Education

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Parents' Education												
None/Primary	11.6	11.8	494.0	5.93	11.5	11.7	471.5	6.92	11.6	11.8	476.4	6.75
Lower Second	21.0	21.4	507.5	3.85	21.5	21.9	479.0	3.67	21.2	21.6	493.6	4.23
Upper Second	30.7	31.3	530.4	3.63	30.1	30.7	509.9	3.62	30.7	31.3	512.5	3.95
Third Level	34.9	35.6	549.4	4.08	34.9	35.7	526.1	3.83	34.7	35.3	541.1	4.80
Missing	1.8	0.0	455.0	14.95	2.1	0.0	432.4	13.93	1.8	0.0	465.5	19.17
All Available	98.2	100.0	526.7	3.24	98.0	100.0	502.9	2.72	98.2	100.0	513.4	3.18
Mean Score Differences (Reference Category: Upper Second Level)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
N/Prim–Up Sec	–36.4	6.95	**–54.2**	**–18.7**	–38.4	7.80	**–58.4**	**–18.5**	–36.1	7.82	**–56.1**	**–16.2**
Lwr Sec–Up Sec	–23.0	5.29	**–36.5**	**–9.5**	–30.9	5.15	**–44.0**	**–17.7**	–18.9	5.78	**–33.7**	**–4.2**
3rd Lev–Up Sec	18.9	5.46	**5.0**	**32.9**	16.2	5.26	**2.7**	**29.6**	28.6	6.21	**12.7**	**44.4**
Missing–Up Sec	–75.5	15.39	**–114.8**	**–36.1**	–77.5	14.39	**–114.3**	**–40.7**	–47.0	19.57	–97.0	3.0

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Family Structure

Students were asked to indicate (a) whether or not they lived in a household headed by a lone parent; and (b) the number of siblings in their family. Of those students who completed the reading literacy assessment, 12.8% reported living in lone parent households (Table 4.15). These students had significantly lower mean scores on combined reading literacy, mathematical literacy and scientific literacy than their counterparts not living in lone parent families. For each assessment domain, the difference is more than one quarter of a standard deviation.

Table 4.15. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students and Mean Score Differences, by Lone Parent Status

	Combined Reading Literacy				Mathematical Literacy				Scientific Literacy			
	%T	%A	Mean	SE	%T	%A	Mean	SE	%T	%A	Mean	SE
Lone Parent Household												
Yes	12.7	12.8	505.9	6.09	13.3	13.4	480.5	6.38	13.3	13.4	493.7	6.84
No	86.4	87.2	530.5	3.23	85.7	86.6	507.2	2.80	85.9	86.6	516.9	3.36
Missing	0.9	0.0	455.1	20.23	1.0	0.0	434.2	20.58	0.8	0.0	463.7	21.13
All Available	99.1	100.0	526.7	3.24	99.0	100.0	502.9	2.72	99.2	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students in Lone Parent Households)												
	Diff	SED	BCI95%		Diff	SED	BCI95%		Diff	SED	BCI95%	
No–Yes	24.6	6.90	**8.9**	**40.3**	26.7	6.97	**10.7**	**42.6**	23.2	7.62	**5.8**	**40.6**
Missing–Yes	–50.8	21.13	**–99.1**	**–2.5**	–46.3	21.55	–95.6	2.9	–30.0	22.21	–80.7	20.7

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Additional tables detailing the scores in reading literacy, mathematical literacy and scientific literacy of male and female students who live/do not live in lone parent households and the significance of differences between their mean scores may be found in Appendix 4 (Tables A4.6 to A4.8).

Table 4.16. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Number of Siblings

	Combined Reading Literacy				Mathematical Literacy				Scientific Literacy			
	%T	%A	Mean	SE	%T	%A	Mean	SE	%T	%A	Mean	SE
Number of Siblings												
None	4.0	4.0	529.7	8.03	3.8	3.9	504.5	9.47	4.0	4.0	526.5	9.96
One	18.9	19.1	537.9	3.44	19.4	19.6	512.9	4.13	19.4	19.6	527.3	4.30
Two	29.0	29.3	538.8	4.00	29.5	29.5	511.4	4.14	29.2	29.6	522.1	4.86
Three	21.9	22.2	530.0	4.57	21.4	21.7	508.5	4.18	21.3	21.6	519.5	5.09
Four or >	25.1	25.3	504.6	5.20	24.7	25.0	484.0	5.09	24.9	25.2	487.7	5.27
Missing	1.1	0.0	441.7	12.42	1.2	0.0	420.5	15.89	1.2	0.0	457.2	16.99
All Available	98.9	100.0	526.7	3.24	98.8	100.0	502.9	2.72	98.8	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students with Two Siblings)												
	Diff	SED	BCI95%		Diff	SED	BCI95%		Diff	SED	BCI95%	
None–Two	–9.1	8.97	–32.8	14.6	–6.9	10.33	–34.2	20.4	4.4	11.09	–24.9	33.6
One–Two	–0.9	5.27	–14.8	13.0	1.5	5.85	–13.9	16.9	5.2	6.49	–11.9	22.3
Three–Two	–8.8	6.07	–24.8	7.2	–2.9	5.89	–18.4	12.6	–2.6	7.04	–21.2	15.9
Four or>–Two	–34.2	6.56	**–51.5**	**–16.9**	–27.4	6.56	**–44.7**	**–10.1**	–34.4	7.17	**–53.4**	**–15.5**
Missing–Two	–97.1	13.05	**–131.5**	**–62.7**	–90.9	16.42	**–134.2**	**–47.5**	–64.9	17.67	**–111.6**	**–18.3**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Just 4% of students did not have any brothers or sisters, while 25% had four or more (Table 4.16). The differences in mean combined reading literacy, mathematical literacy and scientific literacy scores between students with four or more siblings and students with two (the designated reference category) are statistically significant, with students with two siblings achieving the higher mean scores. Indeed, the difference in mean scores on combined reading literacy between students in these categories is in the order of one-third of a standard deviation. On the other hand, mean score differences between other groups (for example, between students with no siblings and those with two) are small and do not reach statistical significance.

Home Educational Climate Variables

Students responded to a series of questions designed to generate information about home educational climate. Three indicators of interest emerged from the subsequent analysis of the data: academic interest of parents, quantity of home educational resources, and number of books in the home.

Parental Engagement

A composite variable, parental engagement, was constructed using students' responses to questions about the frequency with which their parents engaged with them in (i) discussing politics or social issues; (ii) discussing books, films or television programmes; and (iii) listening to classical music. The mean combined reading literacy score of students who reported high levels of parental engagement is some 22 points higher than that of students who reported medium levels – a relatively large and statistically significant difference (Table 4.17). The difference in mean scientific literacy scores of students reporting high and medium levels is also in the order of 22 points, and reached statistical significant at the .05 level, in favour of students who reported high levels. No significant difference in mean mathematical literacy scores was found for students reporting high and medium engagement levels. Mean differences in achievement between students reporting medium and low levels of parental engagement are statistically significant across all three assessment domains, with students reporting medium levels achieving the higher mean scores. Differences are greatest for reading literacy and least for mathematical literacy.

Table 4.17. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Parental Engagement

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Parental Engagement												
High	39.4	39.9	548.5	3.83	38.8	39.4	514.0	3.72	40.2	40.7	532.9	4.17
Medium	28.4	28.8	526.8	3.36	28.3	28.7	506.4	3.86	28.5	28.9	511.2	4.35
Low	30.8	31.2	504.3	4.15	31.4	31.9	492.0	4.28	30.0	30.4	493.0	4.33
Missing	1.4	0.0	399.7	17.85	1.6	0.0	385.1	18.54	1.3	0.0	424.2	21.73
All Available	98.6	100.0	526.7	3.10	98.5	100.0	502.9	2.66	98.7	100.0	513.4	3.14
Mean Score Differences (Reference Category: Students Reporting Medium Levels of Parental Engagement)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Med	21.7	5.09	**9.2**	**34.2**	7.7	5.36	–5.4	20.8	21.7	6.03	**7.0**	**36.4**
Low–Med	–22.5	5.34	**–35.6**	**–9.4**	–14.4	5.76	**–28.5**	**–0.3**	–18.2	6.14	**–33.2**	**–3.2**
Missing–Med	–127.1	18.16	**–171.5**	**–82.7**	–121.3	18.94	**–167.6**	**–75.0**	–87.0	22.16	**–141.2**	**–32.8**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Home Educational Resources

Students indicated whether or not they had each of the following educational resources at home: a dictionary, a quiet place to study, a desk for studying, and textbooks. A weighted likelihood estimate composite, quality of home educational resources, was constructed based on students' responses. Across all subject domains, differences in mean achievement scores between students with high and medium levels of educational resources at home are statistically significant, favouring students with high levels (Table 4.18). Similarly, mean score differences across the three domains between students with medium and low levels of educational resources are statistically significant. Mean score differences between students with medium and low levels of educational resources – about one third of a standard deviation for combined reading literacy and mathematical literacy, and one quarter of a standard deviation for mathematical literacy – are larger than those between students with high and medium levels (about 20 points in all three domains).

Table 4.18. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Availability of Home Educational Resources

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Availability of Home Educational Resources												
High	50.6	51.0	544.6	3.24	50.0	50.5	521.5	3.11	49.8	50.1	529.4	3.91
Medium	27.2	27.4	524.3	4.29	26.9	27.1	501.6	4.20	27.6	27.8	509.2	5.07
Low	21.5	21.6	490.6	4.92	22.2	22.4	466.2	4.65	21.9	22.1	484.2	5.30
Missing	0.8	0.0	438.4	16.35	0.9	0.0	420.8	17.75	0.7	0.0	450.5	22.68
All Available	99.3	100.0	526.7	3.20	99.1	100.0	502.9	2.71	99.3	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students with Medium Levels of Educational Resources)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Med	20.3	5.38	**7.2**	**33.5**	19.9	5.23	**7.1**	**32.7**	20.2	6.40	**4.5**	**35.9**
Low–Med	–33.7	6.53	**–49.7**	**–17.8**	–35.4	6.27	**–50.7**	**–20.1**	–25.0	7.33	**–42.9**	**–7.1**
Missing–Med	–85.9	16.90	**–127.2**	**–44.6**	–80.8	18.24	**–125.3**	**–36.2**	–58.7	23.24	**–115.5**	**–1.9**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Books in the Home

Students were asked to indicate the number of books at home along the following scale: none, 1-10, 11-50, 51-100, 101-250; 241-500 and more than 500. In reporting results here, the categories 'none' and 1-10 were collapsed to form a new category, 0-10, as there were very few students in the 'none' category. Similarly, the categories 250-500 and more than 500 were collapsed to form the category, 'more than 250'. Almost 10% of students reported having 10 or fewer books at home (Table 4.19).

On the other hand, over one in five had between 51 and 100 books, while one in four had more than 250 books. Significant differences in combined reading literacy, mathematical literacy and scientific literacy were found in favour of students with 101-250 books and students with more than 250 books over students with 51-100 books (the reference category). Similarly, statistically significant mean score differences in all three PISA domains were found in favour of students with 51-100 books over students with 11-50 books and students with 0-10 books. The mean score differences between those with 0-10 books and those with 51-100 are quite large – 52.1 points (over one half of a standard deviation) for combined reading literacy, 53.5 points (again, over one half of a standard deviation) for scientific literacy, and 39.8 points (almost one half of a standard deviation) for mathematical literacy.

Tables detailing associations between number of books in the home, gender and achievement in reading literacy, mathematical literacy and scientific literacy and the significance of differences in mean between males and females in each domain at different levels of number of books in the home may be found in Appendix 4 (Tables A4.9 to A4.11).

Table 4.19. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Index of Books in the Home

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Index of Books in the Home												
0–10	9.5	9.7	470.1	6.49	9.8	9.9	459.5	7.19	9.6	9.7	456.8	7.22
11–50	21.7	22.0	498.8	4.00	20.8	21.1	476.4	5.18	22.2	22.5	486.2	4.59
51–100	21.1	21.3	522.2	4.07	22.8	23.1	499.3	4.20	21.1	21.4	510.3	4.71
101–250	22.2	22.5	545.0	4.11	21.9	22.3	516.5	4.19	21.8	22.1	532.7	5.02
More than 250	24.1	24.4	566.3	4.18	23.3	23.6	540.9	4.46	24.0	24.3	549.9	4.93
Missing	1.4	0.0	437.0	14.66	1.5	0.0	418.9	18.9	1.3	0.0	446.6	18.56
All Available	98.6	100.0	526.7	3.17	98.5	100.0	502.9	2.68	98.7	100.0	513.4	3.17
Mean Score Differences (Reference Category: Students with 51-100 books at home)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
0-10–51-100	–52.1	7.66	**–72.3**	**–31.9**	–39.8	8.33	**–61.7**	**–17.8**	–53.5	8.62	**–76.2**	**–30.8**
11-50–51-100	–23.4	5.71	**–38.5**	**–8.3**	–22.9	6.67	**–40.5**	**–5.3**	–24.1	6.58	**–41.5**	**–6.7**
101-250–51-100	22.8	5.78	**7.5**	**38.1**	17.2	5.93	**1.6**	**32.9**	22.4	6.88	**4.2**	**40.6**
>250–51-100	44.1	5.83	**28.7**	**59.5**	41.6	6.13	**25.4**	**57.7**	39.6	6.82	**21.6**	**57.6**
Miss.–51-100	–85.2	15.21	**–125.4**	**–45.0**	–80.4	19.36	**–131.5**	**–29.3**	–63.7	19.15	**–114.2**	**–13.2**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Student as Learner

Students were asked about their future study plans, their involvement in learning support (remedial) classes at school, how long they spent on homework, whether or not they studied science, and the levels at which they studied English, mathematics, and science (if applicable) in the Junior Cycle. They were also asked whether or not they used a calculator during the PISA assessment and about their use of different strategies during learning.

Academic Orientation

Students were asked to indicate their intentions with regard to: (i) remaining in school after the Junior Certificate examination; (ii) taking the Leaving Certificate examination; and (iii) attending a third-level college or university after finishing second-level schooling. Students who provided a 'yes' response to all three items were regarded as having a high academic orientation. Just over 75% of students for whom responses to these questions were available, were regarded as having a high academic orientation (Table 4.20).

Table 4.20. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Students' Academic Orientation

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Academic Orientation												
High	72.7	75.6	551.2	2.70	72.1	75.2	522.0	2.57	73.1	76.1	534.9	3.12
Low	23.5	24.4	462.3	4.24	23.8	24.8	456.5	4.47	23.0	23.9	455.1	4.93
Missing	3.9	0.0	455.9	7.16	4.2	0.0	436.2	8.88	4.0	0.0	454.5	10.50
All Available	96.2	100.0	526.7	3.16	95.9	100.0	502.9	2.61	96.1	100.0	513.4	3.13
Mean Score Differences (Reference Category: Students with High Academic Orientation)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Low–High	–88.9	5.03	**–100.4**	**–77.4**	–65.5	5.16	**–77.3**	**–53.8**	–79.8	5.83	**–93.1**	**–66.4**
Missing–High	–95.3	7.65	**–112.8**	**–77.8**	–85.9	9.24	**–107.0**	**–64.8**	–80.4	10.95	**–105.4**	**–55.4**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Differences in mean scores between students with high and low levels of academic orientation are statistically significant for reading literacy, mathematical literacy and scientific literacy. Moreover, the differences between those with high and low academic orientation are large: over three-quarters of a standard deviation in each assessment domain.

Dropout Risk

To obtain a measure of whether or not students were at risk of dropping out of school, they were asked to indicate (i) whether or not they intended to complete a programme leading to the Leaving Certificate examination; and (ii) whether or not they agreed with each of eight statements relating to attendance at school (e.g., 'I don't like school'; 'A lot of my friends are leaving school', 'My teachers think I should leave school'). Students were categorised as being at risk of dropping out of school if they did not intend to study for the Leaving Certificate and indicated agreement with at least one of the 8 statements. Based on these criteria, 13.9% of students were identified as being at risk (Table 4.21). Mean differences in reading literacy, mathematical literacy and scientific literacy of students who are or are not at risk are all statistically significant, with the at-risk students having the lower mean scores. These mean score differences are in the region of one standard deviation for each assessment domain.

Table 4.21. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Dropout Risk

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Dropout Risk												
Yes	13.9	14.0	431.6	5.33	14.2	14.3	435.3	5.66	14.2	14.3	431.5	6.20
No	85.4	86.0	542.9	2.64	85.0	85.7	515.0	2.46	85.1	85.7	527.6	2.90
Missing	0.7	0.0	438.1	15.14	0.8	0.0	426.0	16.41	0.7	0.0	447.4	23.41
All Available	99.3	100.0	526.7	3.24	99.2	100.0	502.9	2.72	99.3	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students with Dropout Risk)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
No–Yes	111.3	5.95	**97.7**	**124.9**	79.7	6.17	**65.6**	**93.8**	96.1	6.84	**80.5**	**111.7**
Missing–Yes	6.5	16.05	–30.2	43.1	–9.3	17.36	–49.0	30.3	16.0	24.22	–39.4	71.3

Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Learning Support – English

Students were asked to indicate whether or not they attended learning support classes for English in their schools at any time in the three years prior to the assessment. Fewer than 6% of students indicated that they had (Table 4.22). These had mean achievement scores in the three assessment domains that are one standard deviation lower than the mean scores of students who had not attended such classes. The finding that students attending learning support classes in English also experienced low achievement in mathematical literacy and scientific literacy could indicate that their learning difficulties extend to a broad range of subjects.

Table 4.22. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Attendance at Learning Support Classes (English)

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Learning Support Classes												
Yes	5.8	5.9	418.8	8.60	5.8	6.0	425.4	9.81	5.6	5.7	427.5	8.96
No	91.2	94.1	534.6	2.97	90.6	94.0	510.0	2.70	92.5	94.3	519.3	3.04
Missing	3.0	0.0	493.3	12.4	3.6	0.0	449.8	13.76	1.9	0.0	478.9	17.85
All Available	97.0	100.0	526.7	3.24	96.4	100.0	502.9	2.72	98.1	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students Attending L-S Classes)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
No–Yes	115.8	9.10	**95.1**	**136.6**	84.6	10.17	**61.4**	**107.9**	91.9	9.46	**70.3**	**113.5**
Missing–Yes	74.6	15.09	**40.1**	**109.0**	24.4	16.90	–14.2	63.0	51.5	19.97	**5.8**	**97.1**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134; L-S = learning support; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Absence from School

Students were asked to indicate the number of days on which they were absent from school in the two weeks prior to the assessment, using a three-point scale ('none', 'one or two', 'three or more'). Of students who responded to this question, 57.3% indicated that they had not missed any days, while just under 9% said that they had missed three or more days (Table 4.23). The differences in mean combined reading literacy and scientific literacy scores of students who were not absent from school and those who were absent for 1-2 days are statistically significant. The difference in mean mathematical literacy scores of students in these categories is not statistically significant at the .05 level. However, the difference does reach significance at the .10 level (Bonferroni 90% Confidence Interval: 1.0, 22.6). Differences in achievement between those with exemplary attendance records and those who missed 1-2 days are relatively small – 16.2 points in the case of combined reading literacy, for example.

Table 4.23. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Frequency of Absence from School

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Absence												
No days	56.4	57.3	537.2	3.45	55.8	56.9	510.9	3.35	56.0	56.8	524.1	3.93
1-2 days	33.3	33.8	521.1	3.71	34.1	34.7	499.2	3.69	33.4	34.0	507.4	4.24
3 or more days	8.7	8.9	493.7	7.29	8.3	8.4	480.1	7.34	9.1	9.2	480.8	8.54
Missing	1.6	0.0	448.0	13.49	1.9	0.0	433.0	13.21	1.5	100.0	445.3	18.27
All Available	98.4	100.0	526.7	3.24	98.2	100.0	502.9	2.72	98.5	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students Missing on 1-2 days)												
	Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
No ds – 1-2 ds.	16.2	5.06	**3.8**	**28.5**	11.8	4.98	–0.4	24.0	16.6	5.78	**2.5**	**30.8**
3/> – 1-2 ds	–27.4	8.18	**–47.4**	**–7.4**	–19.0	8.22	–39.1	1.1	–26.6	9.53	**–49.9**	**–3.3**
Missing – 1-2 ds	–73.1	13.99	**107.3**	**38.9**	–66.1	13.71	**–99.6**	**–32.6**	–62.2	18.76	**–108.0**	**–16.3**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Homework and Study

Students were asked two questions about homework. One concerned the amount of time they spent doing homework and study in English, mathematics and science in a typical school week, including weekends. The second asked whether or not homework was completed on time. Just over 8% of students indicated that they did not spend any time on homework and study, while 21.4% said that they spent more than three hours (Table 4.24). Among students who attempted the assessment of scientific literacy, 12.7% indicated that they did no homework/study in science, while a further 11.0% indicated that the question was not applicable because they did not study science as a school subject. Students who did more homework and study in a subject generally achieved higher scores in the corresponding assessment domain than their counterparts who did less homework. However, the mean achievement scores of students who spent no time on homework in English or mathematics are not significantly different from those of students who spent less than one hour per week on homework/study in these subjects. Similarly, although not tested for statistical significance, the differences between the mean scores of students who spent more than three hours a week doing homework and those who spent less are small, suggesting a trend of diminishing returns where large amounts of homework are concerned. This pattern was consistent across the three PISA assessment domains. Students who did not study science as a subject achieved a mean scientific literacy score that is 58.4 points (over two-thirds of a standard deviation) lower than that of students who did homework and study in the subject for under an hour a week, though other factors, such as exposure to scientific concepts and processes during science classes, may also have influenced this outcome.

Table 4.24. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Time Spent on Homework and Study

	Homework – English				*Homework – Math*				*Homework – Science*			
	%T	*%A*	*Mean C Rdg. Lit*	*SE*	*%T*	*%A*	*Mean Math. Lit*	*SE*	*%T*	*%A*	*Mean Sci. Lit*	*SE*
Time Spent on Homework and Study												
No time	8.3	8.4	502.0	7.81	7.1	7.3	471.6	8.11	12.3	12.7	500.2	6.85
Less than 1 hr	26.6	27.0	516.9	5.05	25.7	26.1	489.5	4.44	25.9	26.7	516.5	5.25
1-3 hrs	42.6	43.2	537.0	3.21	42.0	42.7	512.5	3.44	31.9	32.9	530.2	4.03
More than 3 hrs	21.1	21.4	533.7	4.19	23.5	23.9	516.7	4.06	15.8	16.3	530.1	5.10
Subj. not studied	-----	-----	-----	-----	-----	-----	-----	-----	11.0	11.4	458.1	8.20
Missing	1.4	0.0	441.2	13.64	1.6	0.0	400.0	18.00	3.1	0.0	477.7	14.35
All Available	98.6	100.0	526.7	3.24	98.4	100.0	502.9	2.72	96.9	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students Who Spent Less than an Hour Studying).												
	Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
No time–<1hr	–14.8	9.30	–38.6	8.9	–17.9	9.24	–41.5	5.7	–16.3	8.63	–39.1	6.5
1-3hrs–<1hr	20.1	5.98	**4.8**	**35.4**	23.0	5.61	**8.7**	**37.3**	13.8	6.62	–3.7	31.2
>3hrs–<1 hr	16.9	6.56	**0.1**	**33.7**	27.2	6.01	**11.8**	**42.6**	13.6	7.32	–5.7	32.9
Not studied–<1hr	----	-----	-----	-----	-----	-----	-----	-----	–58.4	9.74	**–84.1**	**–32.7**
Missing–<1hr	–75.7	14.54	**–112.8**	**–38.5**	–89.5	18.54	**–136.9**	**–42.2**	–38.8	15.28	–79.1	1.5

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.
Bonferroni Confidence Intervals have been adjusted for 4 comparisons for reading literacy and mathematics, and 5 for science, as an extra category, ‘subject not studied’ is taken into account.

Students were asked to indicate how often they completed homework across all school subjects on a four-point scale ranging from 'never' to 'always'. Almost 5% of students indicated that they never completed homework on time, while just over 21% said that they always did (Table 4.25). No differences in mean achievement scores were found for any of the PISA assessment domains between students who 'always' completed their homework on time, and those who did so 'most times'. On the other hand, in all three domains, students who mostly completed their homework on time have mean achievement scores that are around one-third of a standard deviation higher than those of students who sometimes completed their homework on time.

Table 4.25. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Frequency of Completion of Homework on Time

	C. Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Completion of Homework on Time												
Never	4.7	4.8	473.0	9.22	4.6	4.7	477.9	8.10	5.1	5.2	458.6	10.24
Sometimes	22.8	23.1	505.7	4.44	22.7	23.0	483.2	4.88	22.4	22.7	497.0	5.31
Most times	50.0	50.6	537.3	2.89	49.4	50.2	510.6	3.06	50.6	51.2	522.8	3.20
Always	21.2	21.5	541.4	4.92	21.9	22.2	518.1	4.95	20.6	20.9	524.8	5.65
Missing	1.3	0.0	438.5	15.73	1.4	0.0	398.4	21.77	1.2	0.0	460.7	20.01
All Available	98.7	100	526.7	3.24	98.6	100.0	502.9	2.72	98.7	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students who completed homework 'most of the time')												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Never–Most	–64.3	9.66	**–89.0**	**–39.6**	–32.7	8.66	**–54.9**	**–10.6**	–64.2	10.72	**–91.6**	**–36.8**
Some–Most	–31.6	5.30	**–45.2**	**–18.1**	–27.5	5.75	**–42.2**	**–12.8**	–25.8	6.19	**–41.6**	**–9.9**
Always–Most	4.1	5.71	–10.5	18.7	7.5	5.82	–7.4	22.3	2.0	6.49	–14.6	18.6
Missing–Most	–98.8	15.99	**–139.7**	**–58.0**	–112.3	21.98	**–168.4**	**–56.1**	–62.1	20.26	**–113.9**	**–10.3**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Study of Science

Unlike English and mathematics, science is not a compulsory subject in the Junior Cycle programme. Just over 11% of students who completed the assessment of scientific literacy indicated that they had not studied science for the Junior Certificate examination (Table 4.26.). The mean scientific literacy score of students who studied science is 521.5, compared to a mean score of 458.1 for those who did not study science. The 63.4 point difference is statistically significant, and mirrors in size the gap in achievement in scientific literacy between those who studied science for at least an hour a week, and those who did not study the subject at all.

Table 4.26. Mean Combined Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Study of Science

	Scientific Literacy			
	% Total	*% Available*	*Mean*	*SE*
Study of Science				
Yes	87.6	88.8	521.5	3.16
No	11.0	11.2	458.1	8.20
Missing	1.3	0.0	438.4	16.44
All Available	98.6	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students Studying Science)				
	Diff	*SED*	*BCI95%*	
No–Yes	–63.4	8.79	**–83.5**	**–43.3**
Missing–Yes	–83.1	16.74	**–121.3**	**–44.8**

Note. Total N: Scientific Literacy = 2134; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Current Grade Level

Since PISA involved the selection of an age-based sample (see Chapter 1), a comparison was made between the mean scores of students in the Irish sample who were in the second, third, fourth (transition) and fifth years at the time of the assessment. Sixty-two percent of students who completed the English assessment and responded to the relevant questionnaire item were in third year. Just 3.4% were in second year, while 16.0% and 18.7% were in the fourth and fifth years respectively (Table 4.27). Students in third year achieved significantly higher mean scores on combined reading literacy, mathematical literacy and scientific literacy than their counterparts in second year, while those in fourth and fifth years achieved significantly higher mean achievement scores than those in third year. It is interesting to note that the mean scores of students in fifth year in all three literacy domains are somewhat lower than those of students in fourth year. The relatively large mean difference between the combined reading literacy scores of students in second and third years are striking, and may be related to factors other than content coverage. For example, some 15-year olds in second year may have repeated a year earlier in their schooling because of learning difficulties. However, information on this matter was not collected.

Table 4.27. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Current Grade (Year) Level

	Combined Reading Literacy				Mathematical Literacy				Scientific Literacy			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Current Grade Level												
Second Year (G8)	3.4	3.4	410.7	9.55	3.2	3.2	409.1	12.14	3.4	3.4	425.8	10.49
Third Year (G9)	61.6	62.0	516.9	3.60	60.9	61.4	495.4	3.11	62.0	62.4	504.6	3.86
Fourth Year (G10)	15.8	16.0	568.4	4.52	16.5	16.7	537.3	5.72	15.8	16.0	550.9	5.61
Fifth Year (G11)	18.5	18.7	547.9	4.30	18.6	18.7	516.6	4.48	18.1	18.2	529.6	5.15
Missing	0.7	0.0	438.1	15.14	0.8	0.0	426.0	16.41	0.6	0.0	447.4	23.41
All Available	99.3	100.0	526.7	3.24	99.2	100.0	502.9	2.72	99.4	100.0	513.8	3.18
Mean Score Differences												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Second–Third	–106.2	10.21	**–132.2**	**–80.1**	–86.3	12.53	**–118.3**	**–54.3**	–78.8	11.18	**–107.4**	**–50.3**
Fourth–Third	51.6	5.77	**36.8**	**66.3**	41.9	6.51	**25.3**	**58.5**	46.3	6.81	**28.9**	**63.7**
Fifth–Third	31.0	5.60	**16.7**	**45.3**	21.2	5.45	**7.3**	**35.1**	25.0	6.44	**8.6**	**41.4**
Missing–Third	–78.8	15.56	**–118.5**	**–39.0**	–69.4	16.70	**–112.1**	**–26.7**	–57.2	23.73	–117.8	3.4

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Level of Subjects Studied

At the Junior Cycle level, courses are available at the Higher, Ordinary and Foundation levels for English and Mathematics, and at Higher and Ordinary levels for Science. Students were asked to indicate the level at which they had studied or were studying English, Mathematics and Science for the Junior Certificate examination. Just over 70% of students indicated that they had studied English at Higher level (Table 4.28).

Table 4.28. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Level of Subject Studied

	English				*Mathematics*				*Science*			
	%T	*%A*	*Mean Rdg. L*	*SE*	*%T*	*%A*	*Mean Math L*	*SE*	*%T*	*%A*	*Mean Sci. L*	*SE*
Level of Subject Studied												
Higher	69.4	70.4	562.1	2.12	42.7	43.4	555.8	2.56	64.8	65.7	548.2	2.69
Ordinary	28.1	28.5	450.9	3.89	49.9	50.7	473.3	2.62	22.9	23.2	445.6	5.07
Foundation	1.1	1.1	336.0	9.80	5.9	6.0	392.0	6.81	-----	-----	-----	-----
Not Studied	-----	-----	-----	-----	-----	-----	-----	-----	11.0	11.2	458.1	8.20
Missing	1.5	0.0	443.1	16.74	1.6	0.0	421.6	17.30	1.3	0.0	438.4	16.44
All Available	98.6	100.0	526.7	3.24	98.5	100.0	502.9	2.72	98.7	100.0	513.4	3.18
Mean Score Differences (Reference Category: Ordinary level students)												
	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Higher–Ord	111.2	4.42	**100.3**	**122.0**	82.5	3.66	**73.6**	**91.5**	102.6	5.74	**88.6**	**116.7**
Fndt–Ordinary	–114.9	10.54	**–140.7**	**–89.2**	–81.3	7.30	**–99.2**	**–63.5**	----	-----	-----	-----
Not Studied–Ord	-----	-----	-----	-----	-----	-----	-----	-----	12.5	9.64	–11.1	36.0
Missing – Ord	–7.8	17.18	–49.8	34.2	–51.8	17.50	**–94.5**	**–9.0**	–7.2	17.20	–49.2	34.9

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

The corresponding percentages for the Ordinary and Foundation levels were 28.5% and 1.1% respectively. In contrast, just over 43% of students who completed the assessment of mathematical literacy indicated that they had studied Mathematics at Higher level, while 6.0% stated that they had studied the subject at Foundation level. Among students who completed the scientific literacy assessment, 65.7% indicated that they had studied Science at Higher level, while 11.2% said that they had not studied the subject at all. The difference in mean combined reading literacy scores – about one standard deviation – between students who studied English at the Higher and Ordinary levels is statistically significant. Higher level students also achieved higher mean scores than Ordinary level students in mathematical literacy and scientific literacy. Differences between the mean scores of Ordinary and Foundation level students were significant for both reading literacy and mathematical literacy. The difference between the mean scientific literacy scores of Ordinary level Science students and students who did not study science is not statistically significant.

Use of Calculators in PISA

Students were asked to indicate, on their test booklets, whether they used a calculator during the assessment, as use of a calculator was optional, and depended on whether students normally had access to calculators in mathematics classes.[27] Just over one quarter of students for whom responses were available indicated that they used a calculator in the assessment (Table 4.29).

[27] Students were allowed to use calculators during the assessment if their principal teachers had indicated to the test administrator that students in the school normally used calculators during mathematics lessons.

Table 4.29. Mean Mathematical Literacy Scores of Irish Students, and Mean Score Differences, by Use of Calculators in PISA Assessment

	Mathematical Literacy			
	% Total	*% Available*	*Mean*	*SE*
Use of Calculators in PISA				
Yes	24.2	27.3	526.9	4.47
No	64.5	72.7	501.8	3.10
Missing	11.3	0.0	458.1	8.85
All Available	88.7	100.0	502.9	2.71
Mean Score Differences (Reference Category: Students who Used Calculators in PISA)				
	Difference	*SED*	BCI95%	
No–Yes	–25.2	5.44	**–37.6**	**–12.7**
Missing–Yes	–68.8	9.92	**–91.5**	**–46.2**

Note. Total N: Mathematical Literacy = 2128; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

The mean mathematical literacy score of these students is significantly higher than that of students who indicated that they did not use a calculator. The mean mathematical literacy score of students who used a calculator is also significantly higher than that of students who did not respond to the question. The relatively large percentage (11.3%) who did not respond may have included students who did not reach the final page of their test booklet where the question on calculator usage appeared. These students also had a significantly lower score than students who used a calculator during the assessment. Information on calculator usage was not available for other countries in PISA.

Learning Processes and Strategies

Data were gathered in some OECD countries, including Ireland, on variables relating to students' levels of engagement in a number of learning processes and their self-concepts as learners. These included: control strategies (5 items), effort and persistence (4), frequency of memorisation (4), self-efficacy (4), control expectations (4), use of elaboration strategies (4), instrumental motivation (4), competitive learning (4), co-operative learning (5), academic self-concept (3), verbal self-concept (3), and mathematics self-concept (3). An IRT-based composite was generated for each set of items. A description of the variables underlying each composite, and patterns of performance by students with high, average and low scores on the composites may be found in Appendix 4 (Tables A4.12 and A4.13), while correlations with achievement are presented in a later section of this chapter.

Reading Habits and Attitudes towards Reading

Four measures of reading habits and attitudes were generated using data from the Student questionnaire. These were diversity of reading, frequency of borrowing library books, frequency of leisure reading, and attitudes towards reading.

Diversity of Reading

Diversity of reading consisted of a weighted likelihood estimate composite based on the frequencies with which students read six types of text (magazines, comic books, fiction books, non-fiction books, e-mails and web pages, and newspapers). Students who reported a high level of reading diversity achieved a significantly higher mean combined reading literacy score that students who reported a medium level (Table 4.30). Similarly, students who reported a medium level of reading diversity had a significantly higher mean achievement score in the same domain than those who reported a low level. Differences between mean scores are over one quarter of a standard deviation.

Table 4.30. *Mean Combined Reading Literacy Scores of Irish Students, and Mean Score Differences, by Reading Diversity*

		Reading Literacy		
	% Total	*% Available*	*Mean*	*SE*
Reading Diversity				
High	33.5	33.8	553.8	3.80
Medium	27.7	28.0	529.6	3.83
Low	37.7	38.1	503.0	3.94
Missing	1.1	0.0	440.1	16.52
All Available	98.9	100.0	527.6	3.18
Mean Score Differences(Reference Category: Medium Diversity Students)				
	Diff	*SED*	*BCI95%*	
High–Medium	24.1	5.40	**10.9**	**37.3**
Low–Medium	–26.7	5.50	**–40.1**	**–13.2**
Missing–Medium	–89.6	16.96	**–131.0**	**–48.1**

Note. Total N: Reading Literacy = 3854; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Frequency of Borrowing Library Books

Students were asked how often they borrowed books from a school or public library to read for enjoyment. Almost 55% of students reported that they 'hardly ever or never' borrowed library books to read for enjoyment, while 18.4% reported borrowing books at least once a month (Table 4.31). Students who borrowed library books several times a month achieved a significantly higher mean combined reading literacy score than students who never borrowed library books. The difference between the mean scores of students in these groups is about half a standard deviation. The difference in mean reading literacy scores of students who borrowed library books once a month and those who did so a several times a month is not statistically significant at the .05 level. However, the difference, which was in favour of frequent borrowers, is significant at the .10 level (Bonferroni 90% Confidence Interval: -29.4, –0.6).

Table 4.31. *Mean Combined Reading Literacy Scores of Irish Students, and Mean Score Differences, by Frequency of Borrowing Library Books*

		Reading Literacy		
	% Total	*% Available*	*Mean*	*SE*
Borrowing Library Books				
Never or hardly ever	53.8	54.6	510.4	3.87
Few times a year	26.6	27.0	541.4	3.57
About once a month	11.8	12.0	556.4	5.19
Several times a month	6.3	6.4	569.3	7.06
Missing	1.5	0.0	436.3	13.15
All Available	98.5	100.0	526.7	3.24
Mean Score Differences (Reference Category: Students Who Borrowed Books Several Times a Month)				
	Diff	*SED*	*BCI95%*	
Never–Sev a mon	–46.0	6.47	**–62.5**	**–29.5**
Once mon–Sev a mon	–15.0	6.30	–31.1	1.1
Few times yr–Sev a mon	12.9	8.76	–9.5	35.3
Missing–Sev a mon	–120.1	14.14	**–156.2**	**–84.0**

Note. Total N: Reading Literacy = 3854; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Frequency of Leisure Reading

On a third measure of reading habits, students were asked to indicate the amount of time they spent reading for enjoyment on a typical school day. One third of students reported that they spent no time on this activity (Table 4.32). Just under one-third spent less than 30 minutes, while one-fifth spent between 30 minutes and an hour. Fifteen percent spent over one hour. Students who read for up to 30 minutes a day achieved a significantly higher mean achievement score than those who did not spend any of their leisure time reading. Similarly, students who read for 30-60 minutes a day achieved a significantly higher mean combined reading literacy score than students who read for up to 30 minutes. The difference in mean combined reading literacy scores between those reading for over 60 minutes a day and 30 minutes or less is not statistically different at the .05 level. However, a significant difference in favour of those who read for over 60 minutes was found at the .10 level (Bonferroni 90% Confidence Interval: 1.4, 31.1). The difference in mean scores between those who read for up to 30 minutes a day, and those who did not read at all, is 44.6 score points – almost half a standard deviation. On the other hand, the difference in mean scores between those who read for 60 minutes or more a day and those who read for up to 30 minutes is just 16.3 points.

Table 4.32. Mean Combined Reading Literacy Scores of Irish Students, and Mean Score Differences, by Frequency of Leisure Reading

	Reading Literacy			
	% Total	*% Available*	*Mean*	*SE*
Reading for Enjoyment				
No Time	32.9	33.4	491.0	4.14
30 mins or < per day	30.5	30.9	535.6	3.79
30 mins to 60 per day	20.2	20.4	557.5	3.91
60 mins or > per day	15.2	15.4	551.9	5.28
Missing	1.3	0.0	448.5	15.68
All Available	98.7	100.0	526.7	3.24
Mean Score Differences (Reference Category: Students who read for 30 minutes or less per day)				
	Diff	*SED*	*BCI95%*	
No reading–30 mins or less	–44.6	5.61	**–59.0**	**–30.3**
30 to 60–30 mins or less	21.9	5.45	**8.0**	**35.8**
60 or more–30 mins or less	16.3	6.50	–0.4	32.9
Missing–30 mins or less	–87.2	16.13	**–128.4**	**–46.0**

Note. Total N: Reading Literacy = 3854; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Attitude To Reading

Students were presented with nine statements designed to measure aspects of their attitude towards reading (e.g., ‘I find it hard to finish books’; ‘I enjoy going to a bookshop or a library’) and were asked to rate each one on a four-point scale (strongly disagree, disagree, agree, strongly agree). A weighted likelihood estimates composite, based on students’ scores across the nine statements, and taking into account whether statements were positively or negatively worded, was formed. Students were then classified as having good, average or poor attitudes towards reading, depending on whether their scores were in the top, middle or bottom third distribution of score on the composite measure. Students with a good attitude towards reading achieved a significantly higher mean combined reading literacy score than students with an average attitude (Table 4.33). Similarly, students with an average attitude achieved a significantly higher mean score than students with a poor attitude. The difference in achievement between students with good and average attitudes – 62.0 score points, or two-thirds of a standard deviation – is particularly striking.

Table 4.33. Mean Combined Reading Literacy Scores of Irish Students, and Mean Score Differences, by Attitude to Reading

	Combined Reading Literacy			
	% Total	*% Available*	*Mean*	*SE*
Attitude to Reading				
Good	30.8	31.1	582.5	3.07
Average	33.3	33.7	520.5	3.71
Poor	34.9	35.2	486.0	3.73
Missing	1.1	0.0	440.7	15.80
All Available	99.0	100.0	526.7	3.24
Mean Score Differences (Reference Category: Students with Average Attitude)				
	Diff	*SED*	*BCI95%*	
Good–Average	62.0	4.81	**50.2**	**73.8**
Poor–Average	–34.5	5.26	**–47.3**	**–21.6**
Missing–Average	–79.8	16.23	**–119.4**	**–40.1**

Note. Total N: Reading Literacy = 3854; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

In summary, students who were positively disposed towards reading, and/or who read a diverse range of reading materials, achieved substantially higher mean combined reading literacy scores than those who were negatively disposed towards reading and/or read a restricted range of materials. Students who engaged in some leisure reading each day and/or borrowed library books at least a few times a year achieved higher mean combined reading literacy scores than students who did not engage in these reading-related activities.

SCHOOL CHARACTERISTICS AND ACHIEVEMENT

Data on school characteristics were drawn from three sources: responses to questions on the School questionnaire; responses to questions on the Student questionnaire; and data drawn from the Department of Education and Science's database of second-level schools. Three broad categories of school characteristics are considered: school structure, school climate and school resources. Variables drawn from the Department's second-level database were disaggregated to the student level. Those based on the responses of students to the Student questionnaire were first aggregated (averaged) to the school level and then disaggregated to the student level.

School Structure

In this section, five aspects of school structure are considered: stratum; type; management and funding; disadvantaged status; and gender composition.

Stratum

Schools were allocated to strata based on the number of 15-year olds enrolled as follows: large (81 or more 15-year olds), medium (41-80) and small (17-40). Schools with fewer than 17 15-year olds were not included (see Chapter 1). Exactly 70% of students who completed the reading literacy assessment attended schools in the large stratum, while just over 5%

attended schools in the small stratum (Table 4.34). Students attending large schools have a significantly higher mean score (about one fifth of a standard deviation) on combined reading literacy than students attending medium-size schools. No differences in mathematical or scientific literacy were observed for students attending schools in these categories. Students attending medium and small schools did not differ in average achievement on any of the three assessment domains.

Table 4.34. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by School Stratum (Size)

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Percent	*Mean*	*SE*		*Percent*	*Mean*	*SE*		*Percent*	*Mean*	*SE*	
School Stratum												
Large	70.0	532.6	3.50		70.3	506.9	2.94		69.7	517.8	3.63	
Medium	24.9	513.0	7.62		24.7	493.5	6.21		25.1	503.9	6.81	
Small	5.1	512.4	16.09		5.0	494.2	16.16		5.2	500.0	17.11	
All	100.0	526.7	3.24		100.0	502.9	2.72		100.0	513.4	3.18	
Mean Score Differences (Reference Category: Students in Medium Schools)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Large–Med	19.6	8.39	**0.4**	**38.7**	13.4	6.87	–2.3	29.1	13.9	7.72	–3.7	31.5
Small–Med	–0.6	17.80	–41.2	40.1	0.7	17.31	–38.8	40.3	–3.9	18.42	–45.9	38.2

Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Type

Using information from the Department of Education and Science second-level database for the school year 1999-2000, it was possible to categorise each school by type: secondary, community, comprehensive or vocational. Community and comprehensive schools were combined into one category ('community/comprehensive') for analysis purposes. Over six in ten students who completed the assessment of reading literacy attended secondary schools, over one in five attended vocational schools, while almost 15% attended community/comprehensive schools (Table 4.35). In two assessment domains (combined reading literacy and scientific literacy), students in secondary schools achieved a significantly higher mean score at the .05 level than students in community/comprehensive schools. In the third (mathematical literacy), a significant difference was observed at the .10 level (Bonferroni 90% Confidence Interval: 1.6, 27.2). Differences in achievement between students attending secondary and community/comprehensive schools tend to be smaller than those between students attending community/comprehensive and vocational schools.

Table 4.35. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by School Type

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Percent	*Mean*	*SE*		*Percent*	*Mean*	*SE*		*Percent*	*Mean*	*SE*	
School Type												
Secondary	62.7	543.2	3.81		62.9	514.2	3.41		62.5	528.9	3.86	
Vocational	22.4	483.7	6.74		22.0	472.8	5.43		22.9	475.7	7.16	
Com/Comp	14.9	521.9	6.38		15.1	499.8	5.44		14.6	505.7	6.10	
All	100.0	526.7	3.24		100.0	502.9	2.72		100.0	513.4	3.18	
Mean Score Differences (Reference Category: Students in Community/Comprehensive Schools)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Sec–Com/Comp	21.3	7.43	**4.3**	**38.3**	14.4	6.42	–0.3	29.0	23.2	7.22	**6.8**	**39.7**
Voc–Com/Comp	–38.2	9.28	**–59.4**	**–17.0**	–27.0	7.68	**–44.6**	**–9.5**	–30.0	9.40	**–51.5**	**–8.5**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Management and Funding

Principal teachers who responded to the School questionnaire were asked to indicate the percentage of funding (including teacher salaries) that was obtained from government sources, student fees, donations/funds raised by parents, and other sources. Schools were then categorised according to whether: (a) less than 50% of funding was obtained from government sources and the school was not managed by a publicly-accountable body ('private government independent'); (b) more than 50% of funding was obtained from government sources and the school was privately managed ('private government dependent'); and (c) more than 50% of funding was obtained from government sources and the school was managed by a publicly accountable body ('public government dependent'). In Ireland, almost all secondary schools were categorised as 'private government dependent', while all vocational and community/comprehensive schools were categorised as 'public government dependent'.[28]

Fewer than 3% of students who completed the assessment of reading literacy attended privately funded, government independent schools (Table 4.36). Almost four in ten attended community/comprehensive schools, while 57.7% attended secondary schools. Students in schools categorised as private government independent had significantly higher mean achievement scores in the three assessment domains than students in schools categorised as public government dependent. Similarly, students in schools categorised as private government dependent achieved significantly higher mean scores in all three domains than students in schools categorised as public government dependent. Differences in mean achievement scores between students in private government independent and private government dependent schools are large – almost one-half of a standard deviation in the case of combined reading literacy, three-fifths in mathematical literacy, and one half in scientific literacy. Mean score differences between students in private government dependent and public government dependent schools are somewhat smaller – one-third of a standard deviation (mathematical literacy) to two fifths (combined reading literacy and scientific literacy).

Table 4.36. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Source of School Funding/Management

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	Percent	*Mean*		*SE*	*Percent*	*Mean*		*SE*	*Percent*	*Mean*		*SE*
Funding/Management												
Private Govt. Indep.	2.9	586.4		7.59	2.8	561.8		6.22	2.8	579.5		8.80
Private Govt. Dep.	57.7	541.4		3.95	58.1	511.4		3.39	57.8	527.4		3.84
Public Govt. Dep.	39.5	500.6		4.92	39.1	484.9		3.97	39.5	488.6		4.92
All	100.0	526.6		3.30	100.0	502.4		2.74	100.0	513.5		3.24
Mean Score Differences (Reference Category: Students in Private, Government-Dependent Schools												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
PriGI–PriGD	45.0	8.56	**25.4**	**64.5**	50.4	7.08	**34.3**	**66.6**	52.1	9.60	**30.2**	**74.0**
PubGD–PriGD	–40.8	6.31	**–55.2**	**–26.4**	–26.5	5.22	**–38.4**	**–14.6**	–38.8	6.24	**–53.1**	**–24.6**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.
It emerged, in the course of analysing the data, that one school in the private, government-independent category had been misclassified. However, in order to adhere to the international database, the school was not reclassified.

[28] Note that these are OECD classifications.

Disadvantaged Status

Using the Department of Education and Science second-level schools database, schools were categorised according to whether or not they were in the Department's Disadvantaged Area Schools Scheme. Schools in the scheme are provided with additional support, including additional teaching posts and enhanced capitation grants for equipment, resources and home-school liaison initiatives. Just over one-quarter of students who completed the reading literacy assessment attended schools designated as disadvantaged (Table 4.37). The mean achievement scores of students in combined reading literacy, mathematical literacy and scientific literacy in designated schools are significantly lower than those of students attending non-designated schools, with differences ranging from two-fifths of a standard deviation (mathematical literacy) to over one-half (combined reading literacy and scientific literacy).

Table 4.37. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Disadvantaged Status of School

	Reading Literacy			*Mathematical Literacy*			*Scientific Literacy*		
	Percent	*Mean*	*SE*	*Percent*	*Mean*	*SE*	*Percent*	*Mean*	*SE*
Disadvantaged Status									
Designated	25.6	490.4	7.38	25.8	474.7	5.74	25.9	477.6	6.09
Not Designated	74.4	539.2	3.11	74.2	512.7	2.66	74.1	525.9	3.47
All	100.0	526.7	3.24	100.0	502.9	2.72	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students in Designated Schools)									
	Diff	*SED*	*BCI95%*	*Diff*	*SED*	*BCI95%*	*Diff*	*SED*	*BCI95%*
Not Designated – Designated	48.8	8.01	**32.8** **64.7**	38.0	6.33	**25.4** **50.6**	48.2	7.01	**34.3** **62.2**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Gender Composition

Schools were further categorised on the basis of whether they served male students only ('all-boys'), female students only ('all-girls'), or both male and female students ('co-ed'). Almost one-quarter attended all-girls schools, 17.6% attended all-boys schools, and 58.1% attended co-educational schools (Table 4.38). Students attending all-girls schools achieved significantly higher mean combined reading literacy and scientific literacy scores than students of both sexes attending co-educational schools, but the difference in mathematical literacy scores was not significant. Students attending all-boys schools achieved significantly higher mean achievement scores in mathematics and science than students of both sexes attending co-educational schools. Whereas the difference in mean combined reading literacy scores between students attending these school types is not significant at the .05 level, the difference is significant at the .10 level (Bonferroni 90% Confidence Interval: 1.9, 32.3). The difference between the mean combined reading literacy score of students attending all-girls schools and those attending co-educational schools is in the order of one-third of a standard deviation.

Table 4.38. *Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Gender Composition of School*

	Combined Reading Literacy			*Mathematical Literacy*			*Scientific Literacy*		
	Percent	*Mean*	*SE*	*Percent*	*Mean*	*SE*	*Percent*	*Mean*	*SE*
Gender Composition									
All Boys	17.6	532.7	6.11	17.9	527.8	5.70	17.7	530.3	6.91
All Girls	24.3	548.9	5.67	24.4	502.3	5.83	24.3	524.1	6.76
Co-ed	58.1	515.6	4.59	57.8	495.5	3.50	57.9	503.7	4.17
All Students	100.0	526.7	3.24	100.0	502.9	2.72	100.0	513.4	3.18

Mean Score Differences (Reference Category: Students Attending Co-educational Schools)

	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Boys–Co-ed	17.1	7.64	–0.4	34.5	32.3	6.69	**17.1**	**47.6**	26.6	8.07	**8.1**	**45.0**
Girls–Co-ed	33.4	7.29	**16.7**	**50.0**	6.8	6.80	–8.7	22.4	20.4	7.94	**2.3**	**38.5**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

School Climate/Policy

In this section, four aspects of climate/policy are considered: (negative) disciplinary climate, (negative) student behaviour, school autonomy, and frequency of calculator usage in mathematics classes.

Negative Disciplinary Climate

Students were asked to indicate the frequency with which each of several activities occurred during English classes such as ‘Students don’t listen to what the teacher says’ and ‘Students cannot work well’. A weighted likelihood estimate composite, based on students’ responses to six such statements, was formed. Scores were averaged at the school level, and then disaggregated to the student level. For descriptive purposes, scores in the resulting distribution were categorised as high, average or low in relation to negative disciplinary climate, with roughly one-third of students being assigned to each category. Students in schools with high negative disciplinary climate achieved significantly lower mean scientific literacy scores than students in schools with an average (negative) disciplinary climate (Table 4.39). No other mean score differences were statistically significant.

Table 4.39. *Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Negative Disciplinary Climate*

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Negative Disciplinary Climate												
High	34.4	34.4	513.6	6.10	33.0	33.0	496.4	5.04	35.7	35.7	498.6	5.71
Average	32.7	32.7	529.9	5.49	29.7	29.7	506.1	6.06	31.7	31.7	516.7	5.12
Low	33.0	33.0	537.1	5.86	37.3	37.3	506.1	3.81	32.5	32.5	526.3	5.36
All	100.0	100.0	526.7	3.24	100.0	100.0	502.9	2.72	100.0	100.0	513.4	3.18

Mean Score Differences (Reference Category: Students in Schools with an Average Negative Disciplinary Climate)

	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Avg.	–16.3	8.21	–35.0	2.4	–9.7	7.88	–27.7	8.3	–18.1	7.67	**–35.6**	**–0.6**
Low–Avg.	7.2	8.03	–11.1	25.5	0.0	7.16	–16.3	16.4	9.6	7.41	–7.3	26.5

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.
Data for disciplinary climate were collected at the student level. School-level aggregates of these were calculated and matched back to the student level. Hence there are no missing data.

Negative Student Behaviour

Principal teachers indicated the extent to which six practices associated with student behaviour were prevalent in their schools. The practices included ‘disruption of classes by students’, ‘students skipping classes’, and ‘students intimidating or bullying other students’. Weighted likelihood estimates based on the prevalence of all six practices were computed and disaggregated from the school to the student level. For descriptive purposes, scores on the resulting variable, ‘negative student behaviour’, were categorised as ‘high’, ‘average’ and ‘low’. Mean achievement differences between students in schools with high and average negative behaviour are significant for combined reading literacy and scientific literacy, but not for mathematical literacy (Table 4.40). The differences between the mean scores of students in schools with average and low negative student behaviour are not significant for reading literacy and scientific literacy, but do reach significance at the .10 level for mathematical literacy (Bonferroni 90% Confidence Interval: 0.3, 28.8). Where achievement differences are significant at the .05 level, they range from one-fifth of a standard deviation to one-quarter.

Table 4.40. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Negative Student Behaviour

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Negative Student Behaviour												
High	29.9	30.1	507.5	7.05	29.8	30.1	489.7	6.43	29.8	30.1	494.3	6.84
Average	42.5	42.9	529.1	4.17	42.2	42.6	502.7	3.72	42.8	43.1	514.7	4.01
Low	26.7	27.0	544.5	6.34	27.0	27.3	517.2	5.44	26.5	26.8	532.7	6.67
Missing	0.9	0.0	517.2	4.42	0.9	0.0	519.6	4.48	0.9	0.0	510.8	5.50
All Available	99.1	100.0	526.8	3.27	99.0	100.0	502.9	2.72	99.1	100.0	513.4	3.22
Mean Score Differences (Reference Category: Students in Schools with Average Negative Student Behaviour)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Average	–21.6	8.19	**–41.6**	**–1.6**	–13.0	7.42	–31.1	5.2	–20.5	7.93	**–39.8**	**–1.1**
Low–Average	15.4	7.58	–3.2	33.9	14.5	6.59	–1.6	30.6	17.9	7.78	–1.1	37.0
Missing–Avg.	–11.9	6.07	–26.8	2.9	16.9	5.82	**2.6**	**31.1**	–3.9	6.80	–20.6	12.7

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

School Autonomy

School principals were asked to indicate whether or not each of 12 activities listed in the School questionnaire constituted a school responsibility. The activities included ‘appointing teachers’, ‘formulating the school budget’, ‘deciding on teachers’ starting salaries’, ‘choosing textbooks’, and ‘determining course content’. The resulting weighted likelihood estimates composite, School Autonomy, provides an indication of the extent to which a school is free to make its own decisions, or whether it must defer to a higher authority. Students attending schools with high and average levels of autonomy achieved mean scores in each of the three domains that are not statistically significantly different (Table 4.41). Differences between the mean scores of students attending schools with average and low levels of autonomy are statistically significant for reading literacy and mathematical literacy, but not for scientific literacy. Where differences are significant, they are no larger than one-quarter of a standard deviation.

Table 4.41. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by School Autonomy

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
School Autonomy												
High	26.1	26.5	543.5	6.47	26.0	26.4	515.1	6.01	26.2	26.6	529.0	6.66
Average	40.3	40.9	530.5	5.28	40.3	41.0	507.4	4.47	40.3	41.0	515.3	5.56
Low	32.1	32.6	509.5	6.43	32.2	32.7	487.8	4.89	31.9	32.4	498.9	6.48
Missing	1.5	0.0	498.9	15.16	1.5	0.0	495.2	21.11	1.6	0.0	498.5	11.13
All Available	98.5	100.0	526.7	3.24	98.5	100.0	502.9	2.72	98.4	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students in Schools with Average School Autonomy)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Avg.	13.1	8.35	–7.3	33.5	7.8	7.49	–10.6	26.1	13.7	8.68	–7.5	34.9
Low–Avg.	–20.9	8.32	**–41.3**	**–0.6**	–19.6	6.62	**–35.8**	**–3.4**	–16.3	8.53	–37.2	4.5
Missing–Avg.	–31.5	16.05	–70.8	7.7	–12.2	21.58	–65.0	40.5	–16.8	12.44	–47.2	13.6

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Frequency of Calculator Usage

Principal teachers were asked to indicate how often students in third year used calculators in mathematics classes.[29] Just under one-quarter of students were in schools in which calculators were used 'frequently or always' (Table 4.42). However, the mean mathematical literacy score of students attending schools in which calculators were used frequently is not significantly different from the mean of students in schools in which calculators were used only on an occasional basis.

Table 4.42. Mean Combined Reading Literacy Scores of Irish Students, and Mean Score Differences, by Use of Calculators by Third Year Students in Mathematics Classes

	Mathematical Literacy			
	% Total	*% Available*	*Mean*	*SE*
Use of Calculators				
Never	44.3	46.1	502.1	4.03
Occasionally	29.5	30.7	495.9	6.27
Freq/Always	22.3	23.2	513.3	5.87
Missing	4.0	0.0	506.0	11.05
All Available	96.1	100.0	502.8	2.85
Mean Score Differences (Reference Category: Students in Schools in which Calculators Were Used Occasionally)				
	Difference	*SED*	BCI95%	
Never–Occasionally	6.2	7.46	–12.0	24.5
Freq–Occasionally	17.4	8.59	–3.6	38.4
Missing–Occasionally	10.1	12.71	–20.9	41.2

Note. Total N: Mathematical Literacy = 2128; %T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

[29] The use of calculators was introduced in the revised Junior Cycle Mathematics Syllabus that was implemented in schools in the school year following the PISA assessment (2000-01). Students taking the Junior Certificate in 2003 will have access to calculators in the exams in mathematics and other relevant subjects.

School Resources

Three aspects of school resources were examined: two related to human resources (student-teacher ratio and class size) and one dealing with material resources (student-computer ratio).

Student-Teacher Ratio

Principal teachers provided information on school size[30] and on the number of teachers in their schools, both full-time and part-time. A variable, student-teacher ratio, was computed by dividing the school size (total number of students in the school) by the number of teachers in the school.[31] The mean teacher-student ratio was 15.3 (SE = 0.22). For descriptive purposes, students were classified as attending schools with high, medium or low student-teacher ratios.[32] Although students attending schools with high student-teacher ratios achieved higher mean scores that students attending schools with medium or low ratios, only one difference was statistically significant – that between students attending schools with high and medium student-teacher ratios (Table 4.43). The difference was in the order of one-fifth of a standard deviation. No differences in mean achievement were observed between students in schools with medium and low student-teacher ratios.

Table 4.43. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Student-Teacher Ratio

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Student-Teacher Ratio												
High	33.1	33.6	540.3	4.54	33.3	33.8	515.2	3.99	33.1	33.6	527.7	4.82
Medium	32.9	33.3	526.8	4.88	33.6	34.1	498.5	4.29	32.4	32.9	512.1	5.10
Low	32.7	33.1	514.7	7.57	31.7	32.1	495.7	5.75	33.1	33.6	502.2	6.96
Missing	1.4	0.0	480.7	33.10	1.4	0.0	480.5	35.77	1.4	0.0	470.2	35.34
All Available	98.7	100.0	526.7	3.24	98.6	100.0	502.9	2.72	98.6	100.0	513.4	3.18
Mean Score Differences (Reference Category: Students in Schools with Medium Student-Teacher Ratio)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Med.	13.4	6.67	–2.9	29.7	16.7	5.86	**2.4**	**31.1**	15.6	7.02	–1.5	32.8
Low–Med.	–12.2	9.00	–34.2	9.9	–2.7	7.17	–20.3	14.8	–9.9	8.63	–31.0	11.2
Missing–Med.	–46.1	33.46	–127.9	35.7	–17.9	36.03	–106.0	70.2	–41.9	35.70	–129.2	45.4

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Class Size

Students were asked to indicate the number of students in their English, mathematics, and science classes. These data were aggregated to the school level, and school averages were then disaggregated to the student level.[33] For descriptive purposes, students were categorised according to whether they were in large, average, or small classes, using the 33rd and 67th percentile as cut points. Whereas the mean combined reading literacy score of students in average-sized English classes is significantly higher (by almost half of a standard

[30] The variable school size (not reported separately in this chapter) was defined as the number of male and female students in a school, including special education students, and, in Ireland, students enrolled in Post Leaving Certificate (PLC) courses.
[31] Full-time teachers were allocated a weighting of 1.0, while part-time teachers were allocated a weighting of 0.5.
[32] Large student-teacher ratios were defined as those at or above the 67th percentile; small were defined as those at or below the 33rd percentile. The mean student-teacher ratios at the 33rd and 67th percentiles were 14.5 (SE = 0.15) and 15.9 (SE = 0.14) respectively.
[33] The average class size for English was 24.1 (SE = 0.21); for Mathematics, it was 23.5 (SE = 0.20); and for Science, it was 22.9 (SE = 0.23).

deviation) than that of students in small English classes, there is no significant difference in mean scores on the same measure between students in large- and average-sized English classes (Table 4.44). Students in average-sized mathematics classes also achieved a mean mathematical literacy score that is significantly higher (by two-fifths of a standard deviation) than that of students in small-sized mathematics classes. The difference in mean mathematical literacy scores between students in large-sized and average-sized mathematics classes is not significant. Among students who studied science, those in average-sized classes had a significantly higher mean achievement score (about a half of a standard deviation) than those in small classes. Once again, no difference is apparent between the mean scientific literacy scores of students in large- and average-sized science classes.

Table 4.44. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Class Size (Within Subject)

	English Combined Reading Literacy				*Mathematics Mathematical Literacy*				*Science Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Class Size												
Large	33.4	33.4	544.6	4.58	28.2	28.2	518.8	4.56	30.0	33.8	527.2	4.87
Average	33.6	33.6	532.3	5.44	35.9	35.9	506.6	4.23	29.8	33.6	527.2	5.31
Small	33.1	33.1	502.9	6.51	35.9	35.9	486.8	5.72	28.9	32.6	508.6	7.35
All	100.0	100.0	526.7	3.24	100.0	100.0	502.9	2.72	88.8	100.0	521.5	3.16
Mean Score Differences (Reference Category: Students in Average-Sized Classes)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Large–Average	12.3	7.11	–3.9	28.5	12.2	6.22	–2.0	26.4	0.0	7.21	–16.5	16.5
Small–Average	–29.4	8.48	**–48.8**	**–10.1**	–19.8	7.11	**–36.0**	**–3.6**	–18.6	9.07	**–36.64**	**–0.56**

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.
Students who do not study science (11.2%) are excluded from the analyses of achievement in science and class size.

Computer-Student Ratio

School principals were asked to indicate the number of computers in the school that were available for use by 15-year olds. A ratio, the number of computers per student, was computed and disaggregated to the student level. No significant differences in achievement emerged for students in schools with varying levels of computer-student ratio.

Table 4.45. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Computer-Student Ratio

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Computer-Student Ratio												
High	32.1	33.8	519.1	7.03	32.1	33.8	495.8	5.81	31.7	33.4	507.4	7.33
Medium	32.2	33.9	534.8	4.56	32.2	33.9	510.1	4.96	32.1	33.9	518.7	4.71
Low	30.7	32.3	522.6	6.32	30.7	32.3	500.6	4.59	31.1	32.7	511.6	5.90
Missing	5.1	0.0	547.4	10.30	5.1	0.0	517.0	7.62	5.1	0.0	527.9	10.02
All Available	95.0	100.0	526.7	3.24	95.0	100.0	502.9	2.72	94.9	100.0	513.4	3.18
Mean Score Differences (Students in Schools with Average Computer-Teacher Ratio)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
High–Med	–15.6	8.38	–36.1	4.9	–14.3	7.64	–33.0	4.4	–11.4	8.71	–32.7	9.9
Low–Med	–12.1	7.79	–31.2	6.9	–9.5	6.76	–26.0	7.0	–7.1	7.55	–25.6	11.3
Missing–Med	12.6	11.27	–14.9	40.2	6.9	9.09	–15.3	29.1	9.2	11.07	–17.9	36.3

Note. Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

CORRELATIONS BETWEEN EXPLANATORY VARIABLES AND ACHIEVEMENT

Earlier in the chapter, a number of composite variables were split into several ordered categories and achievement scores linked to the different categories were compared. Here the linear associations (correlations) between the uncut composite variables and the achievement scales are given. The linear associations between variables with a number of ordered categories (for example, frequency of absence from school, which had three such categories) and achievement are also provided. Correlation coefficients were not computed for variables not based on ordered categories (for example, student gender).

It should be noted that, while the correlation between explanatory and response variables (for example, number of books in the home and combined reading literacy) may be significant and moderately strong, it cannot be inferred that there is a causal relationship between the variables. One or more additional variables may contribute to the relationship. In Chapter 5, some multilevel models are presented, in which a number of explanatory variables are considered simultaneously.

A note on the computation of correlation coefficients is given in Inset 4.4, while a note on the interpretation of coefficients is given in Inset 4.5.

Inset 4.4. Computation of Correlation Coefficients and Their Critical Values

Correlation coefficients were computed by first running linear regressions involving an explanatory variable and the five plausible values for the corresponding response variable, and obtaining the square roots of the resulting r^2s. Since the estimated *r* coefficients might not be asymptotically normally distributed, each was transformed to a *z* score using Fisher's transformation (Schafer, 1997), and the resulting z scores were averaged and back-transformed. The significance of *r* was determined by computing the *t* statistic (i.e., by dividing the mean coefficient resulting from five linear regressions by its standard error); this also provides a test of linear association in the population. The corresponding *p* value was obtained from a table of critical values of *t*, using 80 degrees of freedom (an approximation based on the number of variance strata in the BRR variance estimation method).

Inset 4.5. Interpretation of Correlation Coefficients

Where the linear association between an explanatory and response variable is reported as a correlation coefficient, the following interpretation applies: a one-standard deviation increase in the explanatory variable is associated with an increase in the response (achievement) variable that is the product of its standard deviation and the correlation coefficient. Moreover, this relationship is symmetrical, implying that a standard deviation increase in the response variable is associated with an increase in the explanatory variable that is the product of its standard deviation and the correlation coefficient.

Correlation coefficients range on a scale from -1.0 to +1.0. A positive correlation indicates that an increase in the value of explanatory variable is associated with an increase in the value of the response variable. A negative correlation indicates that, when the value of one variable increases, the value of the other decreases.

It is useful to make a distinction between correlation coefficients that are significant, and those that represent a substantive relationship between variables. For example, in Table 4.46, the correlation between instrumental motivation and mathematical literacy is .04. Although statistically significant, a correlation this low is unlikely to be *substantively* significant.

Student-Level Variables

The strongest associations between student background variables and achievement are those between socioeconomic status and reading literacy. For example, the correlations between combined parents' socioeconomic status and achievement are .31 for combined reading literacy, .29 for mathematical literacy, and .31 for scientific literacy. The associations between parents' (highest level of) education and student achievement are relatively strong, ranging from .21 for combined reading literacy to .24 for scientific literacy. The correlation between chronological age (in months) and achievement is weak but significant in the case of combined reading literacy (r = .08) and scientific literacy (r = .08), and not significant in the case of mathematical literacy (Table 4.46).

Table 4.46. Standardised Coefficients for the Linear Associations Between Student Variables and Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy

	C. Reading Literacy			*Mathematical Literacy*			*Scientific Literacy*		
	r	*t*	*p*	*r*	*t*	*p*	*r*	*t*	*p*
Background									
Age (in months)	**.082**	3.85	<.001	.044	1.61	.111	**.079**	1.61	.001
Number of Siblings	**–.121**	–6.21	<.001	**–.108**	–4.64	<.001	**–.146**	–5.91	<.001
Mother's SES	**.276**	13.79	<.001	**.276**	10.58	<.001	**.281**	11.95	<.001
Father's SES	**.258**	13.44	<.001	**.243**	9.55	<.001	**.231**	8.48	<.001
Combined Parent SES	**.314**	16.88	<.001	**.292**	11.70	<.001	**.306**	13.42	<.001
Mother's Education	**.206**	8.89	<.001	**.223**	7.61	<.001	**.241**	8.85	<.001
Father's Education	**.188**	8.40	<.001	**.212**	7.62	<.001	**.206**	7.81	<.001
Combined Parents' Educ.	**.212**	9.52	<.001	**.238**	9.13	<.001	**.240**	8.69	<.001
Home Educational Climate									
Parental Engagement	**.194**	9.42	<.001	**.095**	3.43	<.001	**.164**	6.70	<.001
Home Educ. Resources	**.259**	14.03	<.001	**.286**	11.86	<.001	**.221**	8.18	<.001
Books in the Home	**.330**	16.58	<.001	**.323**	12.05	<.001	**.324**	13.14	<.001
Student as Learner									
Absence from School	**–.142**	–7.12	<.001	**–.105**	–3.79	<.001	**–.148**	–3.79	<.001
Time Spent on Study/Hwork	**.105**	5.26	<.001	**.162**	6.41	<.001	**.184**	6.12	<.001
Homework Done on Time	**.181**	10.38	<.001	**.160**	6.69	<.001	**.164**	7.29	<.001
Learning Processes and Strategies									
Control Strategies	**.217**	11.302	<.001	**.154**	5.938	<.001	**.182**	7.186	<.001
Effort and Persistence	**.123**	6.292	<.001	**.082**	3.340	<.001	**.106**	4.353	<.001
Memorisation	**.065**	3.239	<.001	.019	0.742	.230	**.046**	0.742	.046
Self Efficacy	**.237**	10.892	<.001	**.255**	9.926	<.001	**.246**	9.728	<.001
Control Expectations	**.250**	12.199	<.001	**.232**	9.283	<.001	**.220**	8.642	<.001
Use of Elaboration Strategies	**.071**	3.731	<.001	**.062**	2.259	.013	**.065**	2.259	.013
Instrumental Motivation	**.062**	3.346	<.001	**.044**	1.789	.039	**.066**	2.459	.008
Competitive Learning	**.165**	8.282	<.001	**.180**	7.387	<.001	**.195**	7.871	<.001
Co-operative Learning	.012	0.661	.255	**–.071**	–2.956	.002	–.005	–0.178	.430
Self-Concept (academic)	**.287**	13.385	<.001	**.245**	8.767	<.001	**.292**	10.484	<.001
Self-Concept (verbal)	**.038**	1.714	.045	–.029	–1.071	.144	.016	0.528	.300
Self-Concept (mathematics)				**.238**	10.508	<.001			
Reading Habits/Attitudes									
Diversity of Reading	**.246**	11.59	<.001						
Borrowing Library Books	**.216**	9.95	<.001						
Reading for Enjoyment	**.262**	13.46	<.001						
Attitude towards Reading	**.426**	24.60	<.001						

Note. Significant correlations are highlighted in bold. Correlations between time spent on study/homework and achievement are subject-specific (e.g., time spent doing study/homework in English is correlated with combined reading literacy). Students who did not study science were not included when computing the correlations between time spent on study/homework and scientific literacy, or between homework done on time and scientific literacy. Df = 80 (the number of variance strata associated with balanced repeated replicate (BRR) method of variance estimation).

Correlations between home educational climate variables and achievement are relatively strong across the three assessment domains. For example, the correlation between the index of books in the home and combined reading literacy is .33, while that between home education resources and mathematical literacy is .29. Correlations between parental engagement and achievement are somewhat weaker, ranging from .10 for mathematical literacy to .19 for combined reading literacy.

The student as learner variables that relate most strongly to achievement are frequency of completing homework on time and frequency of absence from school. The correlation between frequency of completing homework on time and achievement is somewhat weaker for combined reading literacy (r = .11) than for scientific literacy (r = .18). Correlations between frequency of absence from school and achievement range from –.11 for mathematical literacy to –.15 for scientific literacy (with more frequent absence related to lower achievement).

The learning strategies and processes variables that correlate most strongly with achievement include control expectations, self-efficacy, and academic self-concept. The correlations between academic self-concept and achievement are .29 (reading literacy), .25 (mathematical literacy) and .29 (scientific literacy), while those between self-efficacy (the learner's belief that s/he will succeed on learning tasks) and achievement are .24 (reading literacy), .26 (mathematical literacy), and .25 (scientific literacy).

Among the reading-related variables most strongly associated with achievement on the combined reading literacy scale are attitude towards reading (r = .43) and frequency of reading for enjoyment (leisure reading) (r = .26). The association between frequency of borrowing library books and combined reading literacy is somewhat weaker (r = .22).

School-Level Variables

School-level variables that were derived from the school questionnaire (for example, school autonomy, student-computer ratio) were disaggregated to the student level for analysis. The association between school autonomy (i.e., the level of autonomy that schools enjoyed in making decisions in such areas as budgeting, selection of textbooks, and deciding on course content) is significant for all three domains, with coefficients ranging from .13 for mathematical literacy to .14 for combined reading literacy (Table 4.47). These values indicate that students in schools with greater autonomy in decision-making (according to principal teachers) tend to have higher achievement scores than students in schools in which there is less autonomy. The correlations between negative disciplinary climate and achievement, which range from –.13 for reading literacy to –.03 for mathematical literacy, suggest that students in schools with a low negative disciplinary climate (i.e., good discipline) tend to have somewhat higher mean achievement scores than students in schools with a high negative disciplinary climate. Correlations between negative student behaviour (as rated by school principals) and achievement also indicate that, where negative behaviour is perceived to be less of a problem, achievement tends to be higher.

The correlations between class size and achievement are significant in the case of combined reading literacy (r = .21), mathematical literacy (r = .17), and scientific literacy (r = .10). Students who do well in these areas tend to be in larger classes. The correlations between student-teacher ratio and achievement are significant for all three assessment domains, ranging from .11 for mathematical literacy to .13 for scientific literacy.

Table 4.47. Standardised Coefficients for the Linear Associations Between School Variables and Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy

	Combined Reading Literacy			*Mathematical Literacy*			*Scientific Literacy*		
	r	*t*	*p*	*r*	*t*	*p*	*r*	*t*	*p*
School Autonomy*	**0.138**	2.78	.007	**0.133**	2.78	.001	**0.135**	3.34	.005
Neg. Disciplinary Climate**	**–0.128**	–3.92	<.001	**–0.033**	–1.00	.111	**–0.111**	–2.88	.003
Neg. Student Behaviour*	**–0.182**	–5.57	<.001	**–0.157**	–4.72	<.001	**–0.183**	–5.53	<.001
Student-Teacher Ratio*	**0.120**	3.69	<.001	**0.109**	3.89	<.001	**0.128**	3.44	<.001
Class Size by Subject**	**0.213**	5.54	<.001	**0.169**	5.20	<.001	**0.101**	2.31	.010

Note. Significant correlations are highlighted in bold. Df = 80 (the number of variance strata associated with balanced repeated replicate (BRR) method of variance estimation).
*Variable derived from the School questionnaire.
**Data for negative disciplinary climate and class size were collected at the student level. School-level aggregates of these were calculated and matched back to the student level. Students who did not study science were excluded from the analysis.

CONCLUSION

A broad range of variables are associated with achievement outcomes in PISA. These include student personal and background factors such as gender, parents' socioeconomic status and educational attainment, home background factors, and student learning habits and attitudes. They also include school-level variables such as gender composition, autonomy in decision-making, learning climate and resources for teaching and learning. Inter-relationships between these variables as they relate to learning will be examined in Chapter 5. Here, the main findings in the current chapter are summarised and linked to the findings of earlier studies of educational achievement, while issues that might be investigated further are also identified.

Female students achieved a mean score on the combined reading literacy scale that is 28.7 score points (almost one-third of a standard deviation) higher than that of boys. This is broadly in line with the finding in the IEA Reading Literacy Study some ten years ago that Irish 14-year old female students outperformed their male counterparts by just under one quarter of a standard deviation (Martin & Morgan, 1994). However, gender differences across countries were proportionately greater in PISA than in IEA/RLS, and several OECD countries that did not show significant gender differences in the earlier study were among those with the highest gender differences in PISA (for example, Norway and New Zealand). It is unclear whether the increase in gender differences observed in PISA arise from differences between the IEA/RLS and PISA studies, from broader societal changes since the early 1990s, or from some combination of these. Related to the mean achievement difference between males and females in Ireland is the over-representation of male students at the lowest levels of reading proficiency in PISA.

The finding that Irish male 15-year old students achieved a significantly higher score than female students in mathematical literacy in the present study is not consistent with the non-significant difference between Irish male and female second year students in TIMSS (Beaton et al., 1996a). It appears that the relatively high reading load in the PISA mathematics items (see Chapter 1), and the inclusion of items requiring constructed responses, did not disadvantage boys; moreover, the relatively high emphasis on problem-solving coupled with a low emphasis on routine mathematical procedures may have put boys at an advantage. In general, countries that showed significant differences in achievement in favour of males in mathematics in the OECD analysis of TIMSS data (OECD, 1996) also showed significant gender differences in favour of males in PISA mathematics. However, gender differences in PISA mathematical literacy are smaller than those found in PISA combined reading literacy.

The finding that Irish male students in the present study did not differ significantly from females in achievement in scientific literacy is consistent with the finding of no difference among Irish second year students in TIMSS (OECD, 1996). However, whereas male students in eighth grade significantly outperformed females in 20 OECD countries in TIMSS, male students outperformed females in just four countries in PISA. According to the OECD, the difference between PISA and TIMSS outcomes may, in part, be attributable to a greater emphasis in PISA on life sciences (an area in which females tended to do better than males in TIMSS), and less emphasis on physics (an area in which males tended to do better in TIMSS) (OECD, 2001b).

The finding that parents' socioeconomic status is relatively strongly correlated with the achievement of Irish students in PISA is also consistent with the findings of earlier studies (e.g., Morgan et al., 1997). The 67 point difference (two-thirds of a standard deviation) in mean combined reading literacy scale between students of high- and low-SES parents is particularly striking. Student-level variables that may be associated with SES such as parents' education, home educational resources, parental engagement and number of books in the home were all found to be moderately correlated with achievement outcomes and may interact with SES to influence achievement.

The large achievement differences between students taking Higher level, Ordinary level and Foundation level courses in the Junior Cycle are also striking. Students in third year achieved higher mean scores in the three assessment domains than their counterparts in second year, while those in fourth (transition) year outperformed students in third year in all three assessment domains. Furthermore, students who studied Science at school achieved a mean score on scientific literacy that was two-thirds of a standard deviation higher than that of students who did not study science, though the performance of students who took Ordinary level Science at Junior Cycle level is not significantly different from of students who did not take Science. Taken together, these findings suggest that, although PISA is not based on a particular curriculum or set of curricula, the skills and knowledge it assesses are nonetheless linked to school curricula and programmes of study.

Among the strongest correlations between student-level variables and achievement is that between attitude to reading and combined reading literacy. Students with a good attitude to reading achieved a mean reading literacy score that was one half of a standard deviation higher than that of students with a poor attitude. Similarly, students who reported reading a diverse range of texts and students who read frequently during their leisure time outperformed those who read a narrow range of texts and those who read for enjoyment on a less frequent basis. These findings, which are broadly in line with previous research (e.g, Elley, 1992) support the view that there may be a reciprocal relationship between, on the one hand, attitude, frequency of leisure reading and diversity of reading, and, on the other, reading achievement. Like frequency of doing homework and study, it appears that there is an optimum level of engagement in leisure reading (between 30 minutes and an hour per day), beyond which the relationship with achievement is less straightforward. At the other end of the scale, however, it is noteworthy that one third of 15-year olds spend no time on leisure reading on a typical school day.

Students in secondary schools outperformed students in community/comprehensive schools in all assessment domains (albeit at the .10 level in mathematical literacy), while students in community/comprehensive outperformed students in vocational schools. Mean score differences between students in community/comprehensive and vocational schools were greater than those between students in secondary and community/comprehensive schools. Students in schools in designated areas of educational disadvantage achieved mean scores in all three domains that were significantly lower – by about one half of a standard deviation – than the mean scores achieved by students in schools not designated as disadvantaged. The gender composition of schools was also related to achievement, though not to the same extent as other variables. A difference in the order of one-quarter of a standard deviation in the mathematical literacy assessment favoured students in all-boys schools over students in all-girls schools, and was statistically significant.

Students in average-sized classes achieved higher mean scores in reading literacy, mathematical literacy and scientific literacy than students in small classes in the corresponding subject areas (English, mathematics and science), though differences in achievement between students in average-sized and large classes were not significant. A broadly similar finding emerged in TIMSS where there was a positive relationship between class size and achievement for Irish second year students in both mathematics and science. Such a relationship may reflect a tendency for lower-achieving students and/or students in schools serving large numbers of educationally disadvantaged students to be taught in smaller groups. The positive relationship between student-teacher ratio and achievement may be accounted for by similar factors.

The finding that students who had access to a calculator during the PISA assessment achieved a mean score that was over one-quarter of a standard deviation higher than that of students who did not have access to a calculator is a matter of concern, to the extent that items on the test of mathematical literacy were designed to be calculator neutral. Clearly, further research is needed to examine whether the association between calculator usage and achievement is moderated by other factors.

5

Explaining Performance on PISA

In Chapter 4, associations between individual 'explanatory' variables and student achievement on PISA were described. In those analyses, no account was taken of the fact that the explanatory variables may themselves be inter-related, and the method used does not distinguish between effects of variables at different levels (school, student). These issues are addressed in this chapter, in which analyses of the relationships between background variables and the achievements of Irish students on the assessments of reading literacy (combined scale), mathematical literacy, and scientific literacy[34] are described, using hierarchical linear modelling. This technique has the advantage that when total variance in student achievement is partitioned into between- and within-school components, account can be taken of the effects of student-level variables in estimating the effects of school-level variables on achievement.

The chapter is divided into five parts. First, the percentages of total variance in student achievements that lie between and within schools are reported. Second, a hierarchical linear model of student achievement of reading literacy is described. Using the model, the contributions of a number of variables to achievement are estimated. The third and fourth sections describe hierarchical linear models of student achievement which were constructed for mathematical literacy and scientific literacy, respectively. The final section summarises the models and identifies implications associated with findings.

BETWEEN-AND WITHIN-SCHOOL VARIANCE IN ACHIEVEMENT

As noted in Chapter 3, between-school variance divided by total variance gives an indication of the proportion of variance that lies between schools; the greater the value of between-school variance, the more heterogenous the education system is with respect to achievement (Postlethwaite, 1995). Table 5.1 shows the percentages of total variance that lies between schools in each of the three assessment domains for all OECD countries that participated in PISA.[35] The range is wide: from 7.6% to 67.2% for reading literacy, from 5.4% to 52.9% for mathematical literacy, and from 7.6% to 52.8% for scientific literacy. In general, countries with a low percentage of between-school variance for one domain also have low values for the other domains. The Scandinavian countries (Iceland, Sweden, Norway, Finland) have the lowest values, ranging from just 5.4% to 12.3% across the three domains. Countries with the highest values include Belgium, Austria, Poland, and Hungary (the range across the three domains is 51.4% to 62.7%).

PROCEDURES USED IN MULTILEVEL MODELLING

A *hierarchical linear model* is a type of regression model that is particularly suitable for multi-level data. It differs from the ordinary-least-squares (OLS) regression model in that it contains a random component for each level. The aim of hierarchical linear modelling is to construct a model that expresses how a response variable varies with, or is best explained

[34] As indicated in earlier chapters of the report, only certain aspects of mathematical and scientific literacy were assessed in PISA 2000 since both were minor domains, in contrast with reading literacy, which assessed a broad range of reading skills.
[35] These are weighted estimates.

by, the explanatory variables. The response variable (e.g., achievement in reading literacy) is a level 1 (student level) rather than a level 2 (school level) variable.

Table 5.1. Percentages of Total Variance in Achievement in Reading, Mathematical, and Scientific Literacy That Lie Between Schools – Ireland and OECD Countries

Country	*Combined Reading Literacy*	*Mathematical Literacy*	*Scientific Literacy*
Iceland	7.6	5.4	7.6
Sweden	9.7	8.3	8.2
Norway	10.9	8.1	10.0
Finland	12.3	8.1	6.6
New Zealand	16.2	17.5	16.9
Canada	17.6	17.3	16.2
Ireland	**17.8**	**11.4**	**14.1**
Denmark	18.6	17.8	16.0
Australia	18.8	17.5	17.5
Spain	20.7	18.3	18.0
UK	21.4	22.7	24.3
Luxembourg	30.8	25.3	27.6
USA	29.6	32.0	35.6
Portugal	36.8	32.0	31.3
Korea Rep. of	37.4	38.7	38.3
Switzerland	43.4	41.1	41.6
Japan	45.4	49.7	44.4
Greece	50.4	46.9	40.0
Czech Rep.	53.4	43.7	40.3
Mexico	53.4	51.1	40.9
Italy	54.0	42.4	42.2
Germany	59.8	55.2	49.5
Belgium	59.9	54.7	55.4
Austria	60.0	52.3	55.8
Poland	63.2	54.2	51.4
Hungary	67.2	52.9	52.8
OECD Country Avg	***34.7***	***31.4***	***30.6***

Note. Numbers are weighted. Countries are ordered by the magnitude of the between-school variance associated with reading literacy. No data are available for France. Due to the sampling methods used in Japan, the between-school variance includes variance between classes within schools. Source: OECDC 2001a: Tables 2.4 and 3.5

Variables which were considered for inclusion in the hierarchical linear models described in this chapter were ones which showed significant associations with achievement (see Chapter 4) and which are of high policy and theoretical interest. Some of the variables are in fact composite variables and represent a number of individual variables that are closely associated (for example, ‘parental engagement’ was constructed by combining responses to a number of statements regarding the frequency with which parents engaged with students in various activities, such as discussing politics, books, films and television programmes). Where several variables were correlated, or linked theoretically, the one that had the strongest relationship to achievement, and/or which was of particular policy interest, was chosen. Some variables that were significantly associated with achievement (such as the level of Junior Cycle syllabus that the student was studying in English, Mathematics, or Science) were not included in the models in order to maintain a balance between richness and simplicity, and to avoid problems associated with multicollinearity (Hutcheson & Sofroniou, 1999).

It should be noted that, while in Chapters 3 and 4 estimates of student achievement were weighted by normalised population weights (to correct for the sample design effect), the estimates in this chapter are unweighted. However, the explicit stratifying variable, school size (the number of 15-year olds enrolled in each school), is evaluated in the development of each model so that, if required, the design strata can be incorporated into the model. Aitkin et al. (in press) discuss the use of sample weights in regression and note that it is an issue which often causes confusion, arguing that it is at the predictive stage of modelling (i.e., when one wants to make predictions about the population from the final model) that sample weights should be used. They give two reasons for *not* using weights in model building. First, samples from larger sub-populations are given greater weight, even though each observation is representative of an individual, rather than an aggregate. Secondly, deviance changes corresponding to the omission of variables (used for evaluating the significance of terms in the model) vary in proportion to the size of the sample, which is altered by the application of weights.

No cross-level interactions are examined in the models since these were not included as conditioning variables in the models used to generate the achievement scales. Mislevy (1991) points out that failure to include a variable in a conditioning model results in downwardly biased parameter estimates of the variable, the degree of which varies inversely with the correlation between the variable and the conditioning variables.

In some hierarchical linear models, all continuous explanatory variables are centred, so that the intercept corresponds to the expected score of an individual with an average on all continuous variables in the model. Centring can be done around either the grand mean or the group mean, and each results in a different interpretation of the intercept (see Snijders & Bosker, 1999). The models reported in this chapter use uncentred continuous variables. Hence, the intercept has the conventional interpretation of ordinary-least-squared (OLS) regression intercepts (i.e., the value of the linear predictor when the continuous explanatory variables are set to zero). Following the presentation of the final model for each of the three literacy domains, estimates of the effects of example values of the continuous variables used in the model are provided to facilitate the interpretation of results.

For all three literacy domains, the development of the models followed the same procedure, which, as mentioned earlier, began with the selection of an initial set of variables (listed in Appendix 5, Table A5.1), based on theoretical, empirical, and policy criteria, and consultation with the PISA National Advisory Committee.

A preliminary examination of the curvilinearity of the relationship between continuous variables and a single plausible value (achievement estimate) of the outcome measure was carried out through OLS regressions and graphical displays of (i) the standardised residuals plotted against the fitted values of the outcome variable and (ii) the explanatory variable plotted against the outcome variable in which fitted values were overlaid. If the relationship between two variables is curvilinear, it means that the relationship is better expressed by a curved rather than a straight line. The relationships between counted variables which indicated a quantity (such as number of siblings) and achievement were also examined using OLS regressions which fitted the logarithmic[36] and quadratic forms of each such variable. Later in the analysis, hierarchical linear models involving all five plausible values (achievement estimates) were used to evaluate logarithmic and quadratic forms of the variables.

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[36] The formula Log(x) = Ln (x + 0.5) was used, where 0.5 is added if there are any zero counts to produce a defined value on the logarithmic scale. When no values of zero were likely (e.g., index of books in the home, which began at 1), the value of 0.5 was omitted.

Separate hierarchical linear models for each variable were constructed initially to check that, when variables were later entered simultaneously, the parameter estimates did not change substantially, since this would indicate that the explanatory variables in the model were associated in a complex manner. For all estimates, full maximum likelihood estimation was used, enabling deviance tests[37] for both fixed effects and variance components to be carried out. Following procedures described in McCullagh and Nelder (1989), the deviance difference was evaluated using a chi-squared test. Categorical variables were evaluated using omnibus tests of deviance differences, in which the model was fitted both with and without the corresponding set of indicator dummy variables.[38] The HLM software package averages chi-square statistics across plausible value datasets, with degrees of freedom equal to their complete-data values, and this practice was followed for deviance differences. The degrees of freedom for tests of deviance differences were therefore set to the difference in the number of terms between two nested models.

All statistically significant level 1 variables were then entered simultaneously into a single model. Non-significant variables, with the exception of gender, were eliminated using a manual backwards elimination strategy. The significance of variables in the model was re-evaluated each time one was removed. Gender was retained for two reasons: first, it is a variable of key interest, and second, in the presence of any significant interactions between gender and other level 1 variables, a main effect for gender must be present. Variables with borderline significance ($p \leq .10$) were retained until the final refinement of the model, at which stage the more stringent criterion of $p \leq .05$ was applied. Interactions between remaining level 1 variables and gender were explored, and significant ones retained. At this point, a non-significant main effect for gender was removed if it was not involved in interactions with any of the other explanatory variables. Interactions amongst the remaining variables were not examined.

The sequence for level 2 (school level) variables was similar to that followed for level 1 variables. Separate tests of each level 2 variable were carried out through addition to the null model. Level 2 variables were then examined in conjunction with the level 1 model. Initially, all level 2 candidate variables were entered simultaneously and non-significant variables eliminated, also using the manual backwards elimination strategy described above.

All relationships between continuous explanatory variables in the set (such as attitude to reading composite scale) with achievement (e.g., on the combined reading literacy scale) as the response variable were individually examined for curvilinearity, by fitting the original and squared terms of each variable simultaneously; that is, quadratic relations were examined. The significance of squared terms was evaluated using the t-statistic associated with the squared term. Squared terms that were statistically significant were retained, and non-significant variables eliminated using the manual backwards elimination strategy. An exception to this was the index of books in the home (which was already present in a curvilinear relationship, as its log was used).

Finally, all level 1 variables were examined to ascertain, by the addition of random coefficients, if the effects of each varied randomly across schools. This was done variable by variable through an examination of deviance changes (see footnote 35). Factors with more than two categories were examined in the presence and absence of all the corresponding

[37] The deviance is a measure of the goodness-of-fit of a model. Examining the difference in the deviance between nested models allows one to evaluate whether the additional variable(s) associated with the larger model significantly improve the fit.

[38] A *dummy variable* is a numerical variable used in regression analysis to represent subgroups. In the models presented in this chapter, dummy variables with values 0, 1 are used, where a student is given a value of 0 if they are not in a group (e.g., not in a school designated as disadvantaged) or a 1 if they are in the group (e.g., in a school designated as disadvantaged). Dummy variables are useful because they enable one to use a single regression equation to represent multiple groups.

random coefficients for the dummy variables. A significant result, in which the slope of the relationship between a particular variable and achievement varied across schools, would suggest that the effect of a particular variable on achievement differs across schools.

In interpreting the variance of random slopes, it is useful to take the average slope (or difference, in the case of binary variables) into consideration. On the assumption that the values for the slope are Normally distributed, one can say that 95% of the slopes will fall within $\pm$ 1.96 standard deviations of the parameter estimate of the slope. Calculation of this range therefore allows one to infer the values for the slope within which 95% of schools are likely to lie (see Snijders & Bosker, 1999, Chapter 4). Inset 5.1 lists five points to assist in the interpretation of the tables in this chapter.

Inset 5.1. Interpreting the Tables of Multilevel Models

The following points should be borne in mind when interpreting the tables in this chapter.

- The estimates in all tables are unweighted. When variables are added to the null model separately (e.g., Tables 5.2 and 5.4), because the estimates are unweighted, they do not correspond exactly to the parameter estimates provided in Chapter 4. The listwise deletion of cases with missing values implemented by the software (HLM) will also cause a difference in the estimates.
- For categorical variables, the reference category is given alongside the label for the category corresponding to the parameter estimate.
- Where grade level is included, grade 8 = second year; grade 9 = third year; grade 10 = fourth (transition) year, and grade 11 = fifth year.
- Where an interaction term is included, the formal significance test for the main effect is omitted since main effects cannot be sensibly evaluated in the presence of interactions involving them. This also applies to the linear term in a quadratic fit; i.e., only the squared term can be evaluated when ordinary polynomials are used.
- In describing the tables, the parameter estimates are translated into units of standard deviation. It is useful to bear in mind, assuming that student achievement is Normally distributed, that one standard deviation above and below the mean accounts for around 68% of students' scores and two standard deviations above and below the mean account for roughly 95% of scores. The standard deviations for Ireland for each of the three scales are as follows: reading literacy: 93.59; mathematical literacy: 83.59; and scientific literacy: 91.77.

MODEL OF READING LITERACY

Development of the Model

Table 5.2 presents the parameters of each level 1 (student level) variable fitted separately. Note that the natural logarithm (referred to throughout as log) of the index of books in the home[39], rather than the untransformed index, was used due to its superior fit. All coefficients are significant. As examples of how to interpret the parameters, it can be seen that the difference between males and females is 26.7 points (just over one quarter of a standard deviation) on the combined reading literacy scale; and the difference between students not at risk and at risk of dropout is 95.1 points (around one standard deviation).

Following this initial evaluation of variables, all variables shown in Table 5.2 were entered simultaneously. The non-significant variables were removed in sequence, and the

[39] There are seven possible values for the books index: 1 = none; 2 = 1-10; 3 = 11-50; 4 = 51-100; 5 = 101-250; 6 = 251-500; 7 = 500+.

significance of variables retained in the model was re-evaluated each time one was removed. Thus, parental education, diversity of reading, lone parent status, and parental engagement were removed. The gender difference is no longer significant in the presence of the significant level 1 variables (t = 0.45; df = 1195; p = .658). However, since gender is of central policy interest, and a variable which must be retained in the presence of any significant gender interactions, it was retained in the model at this point. The interactions between gender and the other level 1 explanatory variables were then examined by addition to the model separately. Two significant gender interactions emerged: attitude to reading (t = –1.81; df = 202; p = .071), and log (index of books in the home) (t = –2.65; df = 231; p = .008). These terms were then added simultaneously to the level 1 model. The gender × attitude to reading interaction was no longer significant in the presence of the other gender interaction (t = –1.05; df = 122; p = .296); however, the gender × log (index of books) remained significant (t = –2.16; df = 134; p = .030), and was retained.

Table 5.2. Achievement in Reading Literacy: All Level 1 Variables Tested as Separate Models by Addition to the Null Model

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Gender: Male–Female	–26.670	3.157	t = –7.582	3603	<.001
Socioeconomic Status	1.449	0.094	t = 15.439	1627	<.001
Parental Education			Ddiff = 76.225	3	<.001
None/Primary–Upper Sec	–23.663	5.175			
Lower Sec–Upper Sec	–15.580	4.019			
Third Level–Upper Sec	12.159	3.687			
Lone parent: Yes–No	–14.507	4.447	t = –3.262	3603	<.001
Number of Siblings	–6.748	1.022	t = –6.603	3603	<.001
Parental Engagement	16.787	1.590	t = 10.560	501	<.001
Log (books index)	75.992	4.217	t = 18.020	3603	<.001
Dropout Risk: Yes–No	–95.126	4.075	t = –23.343	1189	<.001
Absence			Ddiff = 58.315	2	<.001
No days–1 or 2 days	11.204	3.247			
Three days or more–1 or 2 days	–26.398	5.628			
Homework on Time			Ddiff = 119.680	3	<.001
Never	–50.257	7.109			
Mostly	–26.189	3.456			
Always	6.530	3.532			
Grade Level			Ddiff = 347.111	3	<.001
Grade 8–Grade 10	–135.025	9.086			
Grade 9–Grade 10	–45.410	3.987			
Grade 11–Grade 10	–9.485	5.037			
Diversity of Reading	23.417	1.826	t = 12.826	1367	<.001
Freq. Of Leisure Reading			Ddiff = 321.32	3	<.001
No time–Up to 30 mins	–39.763	3.760			
30–60 mins–Up to 30 mins	19.290	3.955			
> 60 mins–Up to 30 mins	19.364	4.525			
Attitude to Reading	36.936	1.340	t = 27.570	222	<.001

The resulting level 1 model, which includes the gender × log (index of books), is shown in Table 5.3. All coefficients are highly significant. It is worth noting that, even after controlling for home background variables (socioeconomic status, index of books in the home, number of siblings), the coefficient associated with student dropout risk remains high – there is a 55.7 point (over half a standard deviation) difference between the scores of students at risk and not at risk of dropout. It is also of interest to note that the activities and attitudes of students (frequency of leisure reading, their attitude to reading, the frequency with which they are absent from school, and the frequency with which they complete their homework on time) have a significant impact on achievement over and above their home backgrounds.

Table 5.3. Achievement in Reading Literacy: Level 1 Model After Testing for Gender Interactions

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	479.010	10.045			
Gender: Male–Female	31.089	11.469			
Socioeconomic Status	0.775	0.082	t = 9.515	862	<.001
Number of Siblings	–3.870	0.841	t = –4.600	2095	<.001
Log (books index)	41.541	5.682			
Log (books index) × Gender	–19.354	7.294			
Dropout Risk: Yes–No	–55.667	3.810	t = –14.610	478	<.001
Absence			Ddiff = 10.545	2	.005
No days–1 or 2 days	1.092	2.797			
Three days or more–1 or 2 days	–12.238	4.683			
Homework on Time			Ddiff = 11.084	3	.011
Never	–11.464	6.174			
Mostly	–8.395	3.025			
Always	–1.784	3.058			
Grade Level			Ddiff = 295.779	3	<.001
Grade 8–Grade 10	–98.218	7.938			
Grade 9–Grade 10	–35.550	3.347			
Grade 11–Grade 10	–3.047	4.194			
Freq. Of Leisure Reading			Ddiff = 23.408	3	<.001
No time–Up to 30 mins	–0.012	3.343			
30–60 mins–Up to 30 mins	–2.496	3.608			
> 60 mins–Up to 30 mins	–17.911	4.484			
Attitude to Reading	29.630	1.784	t = 16.608	226	<.001
Variance Components					
Level 2 Variance	521.178		χ^2= 548.512	138	<.001
Level 1 Variance	4340.796				

Variables Dropped from Model (In Sequence)

Parental Education	Parental Engagement
Diversity of Reading	Attitude to Reading × Gender
Lone parent Status	

The parameters of each level 2 variable were each tested separately by addition to the null model (Table 5.4). All parameters are statistically significant, though the variable school size (the number of 15-year olds enrolled, which was the explicit stratifying variable used in the sample design) is borderline. Missingness for all level 2 variables was zero, with the exception of student-teacher ratio (1.4%). A non-missing value indicator method was used for this variable, in which student-teacher ratio was nested in a non-missing indicator (see Lindsey & Lindsey, 2001; Inset 5.2). This prevented the loss of data of all students in the two schools that did not provide the information. After entering all level 2 variables simultaneously, non-significant variables were eliminated using the same strategy as with level 1 variables.

Table 5.4. Achievement in Reading Literacy: All Level 2 Variables Tested as Separate Models by Addition to the Null Model

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Negative Disciplinary Climate	–32.695	8.813	t = –3.710	137	<.001
School Type			Ddiff = 53.323	2	<.001
Secondary–Comm, Comp	23.629	8.468			
Vocational–Comm, Comp	–31.283	9.866			
Not designated disadv-Designated disadv	45.435	6.841	t = 6.642	137	<.001
School Gender Composition			Ddiff = 17.027	2	<.001
All Males–All Females	15.001	9.141			
Co–educational–Mixed Sex	32.144	7.654			
School Size (Number of 15–Year Olds)			Ddiff = 5.873	2	.053
Large–Medium	2.742	16.062			
Small–Medium	18.577	8.024			
Student–Teacher Ratio	5.722	1.746	t = 3.278	136	.001

Inset 5.2. Crossed and Nested Variables in Hierarchical Linear Modelling

Crossed Variables

Two variables are said to be *crossed* when they are both fitted to the model as main effects and with an interaction term between them. For example, an interaction between gender and dropout risk would be specified as:

Gender + Dropout + Gender × Dropout.

Nested Variables

One variable is said to be *nested* inside another when the first is present only in the interaction term between both variables, and the second is also present as a main effect. For example, student-teacher ratio is nested in the non-missing indicator for whether or not a value for student-teacher ratio is available:

Non-missing + Non-missing × Student-Teacher Ratio.

In the presence of the level 1 variables, gender composition, school size (small, medium, and large), and non-missing × student-teacher ratio are not significant. Disciplinary climate of the school, school type, and designated disadvantaged status remain significant. All level 1 variables retain significance. The non-significant variables were removed in sequence, and the significance of variables remaining in the model re-evaluated each time. Following the removal of the non-missing × student-teacher ratio term, the non-missing for student-teacher ratio indicator was not significant, so it too was removed from the model. It had been planned to test the significance of interactions between the non-missing indicator for student-teacher ratio and the other variables after non-significant variables were eliminated. However, since student-teacher ratio and its non-missing indicator were not retained in the model, it was not necessary to do this (Table 5.5).

The significance of quadratic terms of continuous variables at both level 1 and level 2 was tested separately. At level 1, significant curvilinear trends were found for socioeconomic status, number of siblings, and attitude to reading. At level 2, the squared term for disciplinary climate (the only continuous variable at this level) was not significant. When entered into the existing model, all squared terms for level 1 variables remain significant and were retained (Table 5.6).

Table 5.5. Achievement in Reading Literacy: Model Prior to Addition of Significant Squared Terms

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	464.203	11.109			
Student-Level Variables					
Gender: Male–Female	31.905	11.358			
Socioeconomic Status	0.736	0.081	t = 9.050	922	<.001
Number of Siblings	–3.210	0.838	t = –4.320	2121	<.001
Log (books index)	40.753	5.640			
Log (books index) x Gender	–19.059	7.241	t = –2.632	247	.009
Dropout Risk: Yes–No	–54.857	3.801	t = –14.432	477	<.001
Absence			Ddiff = 10.120	2	.006
No days–1 or 2 days	1.139	2.777			
Three days or more–1 or 2 days	–11.874	4.681			
Homework on Time			Ddiff = 10.744	3	.013
Never	–10.815	6.157			
Mostly	–8.128	3.010			
Always	–1.525	3.036			
Grade Level			Ddiff = 300.545	3	<.001
Grade 8–Grade 10	–96.874	7.912			
Grade 9–Grade 10	–34.921	3.296			
Grade 11–Grade 10	–1.375	4.111			
Freq. of Leisure Reading			Ddiff = 22.359	3	<.001
No time–Up to 30 mins	–0.239	3.331			
30–60 mins–Up to 30 mins	2.379	3.605			
> 60 mins–Up to 30 mins	–17.456	4.482			
Attitude to Reading	29.434	1.775	t = 16.607	235	<.001
School-Level Variables					
Disciplinary Climate	–12.130	14.997	t = –2.380	134	.017
School Type			Ddiff = 22.665	2	<.001
Secondary–Comm, Comp	3.323	5.500			
Vocational–Comm, Comp	–19.374	6.398			
Not designated disadv-Designated disadv	22.582	4.363	t = 5.184	134	<.001
Variance Components					
Level 1 Variance	4311.112		χ^2= 359.410	134 <.001	
Level 2 Variance	268.744				

Variables Dropped from Model (In Sequence)	
Parental Education	School Gender Composition
Diversity of Reading	School Size
Lone parent Status	Non-missing × Student-Teacher Ratio
Parental Engagement	Non-missing indicator for Student-Teacher Ratio
Attitude to Reading x Gender	

Table 5.6. Achievement in Reading Literacy: Model With Significant Squared Terms Included, Before Testing Significance of Random Coefficients

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	478.130	14.997			
Student-Level Variables					
Gender: Male–Female	31.939	11.408			
Socioeconomic Status	–0.167	0.418			
Socioeconomic Status Squared	0.009	0.004	t = 2.173	588	.030
Number of Siblings	3.601	2.671			
Number of Siblings Squared	–1.226	0.429	t = –2.858	362	.005
Log (books index)	39.458	5.670			
Log (books index) × Gender	–19.155	7.278	t = –2.632	226	.009
Dropout Risk: Yes–No	–55.367	3.794	t = –14.592	487	<.001
Absence			Ddiff = 10.123	2	.006
No days–1 or 2 days	0.916	2.767			
Three days or more–1 or 2 days	–12.017	4.672			
Homework on Time			Ddiff = 10.744	3	.013
Never	–11.430	6.160			
Mostly	–8.165	3.004			
Always	–1.797	3.024			
Grade Level			Ddiff = 300.309	3	<.001
Grade 8–Grade 10	–95.865	7.924			
Grade 9–Grade 10	–34.899	3.287			
Grade 11–Grade 10	–1.462	4.096			
Freq. Of Leisure Reading			Ddiff = 22.359	3	<.001
No time–Up to 30 mins	–2.276	3.411			
30–60 mins–Up to 30 mins	–2.874	3.594			
> 60 mins–Up to 30 mins	–19.328	4.596			
Attitude to Reading	28.933	1.769			
Attitude to Reading Squared	1.957	0.768	t = 2.550	743	.011
School-Level Variables					
Negative Disciplinary Climate	–12.130	14.997	t = –2.380	134	.017
School Type			Ddiff = 22.665	2	<.001
Secondary–Comm, Comp	3.323	5.500			
Vocational–Comm, Comp	–19.374	6.398			
Not designated disadv-Designated disadv	22.582	4.363	t = 5.184	134	<.001
Variance Components					
Level 2 Variance	268.744		χ^2 = 359.410	134	<.001
Level 1 Variance	4311.112				

Variables Dropped from Model (In Sequence)

Parental Education	School Gender Composition
Diversity of Reading	School Size
Lone parent Status	Non-missing × Student-Teacher Ratio
Parental Engagement	Non-Missing Indicator for Student-Teacher Ratio
Attitude to Reading x Gender	

The Final Reading Literacy Model

Before finalising the model, all level 1 variables were tested for significant random variation across schools.[40] One variable, dropout risk, showed significant variation. The random coefficient for dropout risk was therefore added to the final model (Table 5.7).

[40] Small negative deviance differences were associated with some plausible value sets (not always the same set) in the course of testing the random coefficients for SES (+ SES squared), attitude to reading (+ attitude to reading squared), time spent on homework, and the log of the index of books in the home. In these instances, the negative difference was set to zero prior to averaging the five plausible value sets. Random coefficients for interactions between variables were not examined.

Table 5.7. Final Model of Achievement in Reading Literacy With Random Coefficient for Student Dropout Risk

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	479.384	14.828			
Student-Level Variables					
Gender: Male–Female	32.165	11.490			
Socioeconomic Status	–0.178	0.415			
Socioeconomic Status Squared	0.009	0.004	t = 2.227	725	.026
Number of Siblings	3.623	2.668			
Number of Siblings Squared	–1.212	0.428			
Log (books index)	39.523	5.688	t = –2.637	216	.009
Log (books index) × Gender	–19.246	7.298	t = –2.834	404	.005
Dropout Risk: Yes–No	–54.387	3.973	t = –13.689	138	<.001
Absence			Ddiff = 9.810	2	.007
No days–1 or 2 days	1.236	2.796			
Three days or more–1 or 2 days	–11.558	4.716			
Homework on Time			Ddiff = 10.826	3	.013
Never	–11.224	6.202			
Mostly	–8.257	2.980			
Always	–1.663	3.010			
Grade Level			Ddiff = 296.816	3	<.001
Grade 8–Grade 10	–95.846	7.951			
Grade 9–Grade 10	–34.885	3.261			
Grade 11–Grade 10	–1.548	4.049			
Freq. Of Leisure Reading			Ddiff = 25.556	3	<.001
No time–Up to 30 mins	–2.230	3.434			
30–60 mins–Up to 30 mins	–2.854	3.589			
> 60 mins–Up to 30 mins	–19.230	4.588			
Attitude to Reading	28.935	1.780			
Attitude to Reading Squared	1.937	0.766	t = 2.528	804	.012
School-Level Variables					
Negative Disciplinary Climate	–11.682	4.992	t = –2.340	134	.019
School Type			Ddiff = 23.047	2	<.001
Secondary–Comm, Comp	1.795	5.497			
Vocational–Comm, Comp	–20.389	6.518			
Not designated disadv-Designated disadv	22.283	4.299	t = 5.184	134	<.001
Variance Components					
Level 2 Random Effects					
Intercept Variance	220.726				
Dropout			Ddiff = 6.932	2	.031
Dropout Risk Variance	207.588				
Dropout Risk–Intercept Covariance	128.293				
Level 1 Variance	4292.456				

Variables Dropped from Model (In Sequence)

Parental Education	Gender Composition
Diversity of Reading	School Size
Lone parent Status	Student-Teacher Ratio × Non-Missing
Parental Engagement	Non-Missing Indicator for Student-Teacher Ratio
Attitude to Reading x Gender	

As already noted, taking the square root of the variance associated with a random slope and adding ± 1.96 times this value to the parameter estimate gives the range of values that the random slope is expected to have for 95% of schools. For dropout risk, the random variance is 207.6, and the standard deviation 14.4. The range of the difference is thus –26.2 to –82.6. Therefore we would expect that in 95% of schools, being in the group at risk of dropout would result in achievement scores between one-quarter and nine-tenths of a standard deviation lower than the achievement scores of students in the group that are not at risk of dropping out.

In the course of modelling achievement on the reading literacy assessment, the parameters associated with the top category of the frequency of leisure reading changed substantially when all level 1 variables were entered simultaneously. Through a series of comparisons of the model containing frequency of leisure reading only and the model containing frequency of leisure reading compared with one other level 1 variable at a time, it emerged that, when attitude to reading was entered with frequency of leisure reading, the parameter for the 'more than 60 minutes a day' category changed from +19.4 to –21.2. An alternative final model, which omits the attitude to reading variable, is presented in Appendix 5 (Table A5.2). The parameter estimates in the alternative model are similar to those in Table 5.7. It is perhaps counterintuitive that the sign for the high frequency category changes from +19.4 to –21.2 (around two-fifths of a standard deviation) when attitude to reading is added; the finding requires further investigation. It appears to be related to Simpson's paradox where the association between an explanatory variable and an outcome variable changes direction with the addition of a second explanatory variable (see, for example, Agresti & Finlay, 1997, pp. 370-371). However, note that the variable frequency of leisure reading has an additional two parameters which also need to be examined. One hypothesis which seems reasonable is that, once attitude to reading is taken into account, high amounts of leisure reading are associated with lower levels of reading literacy.

To estimate the proportion of variance in student achievement in reading literacy explained by the model at both student and school levels, the variance components associated with the model prior to inclusion of the random coefficient for dropout risk (Table 5.6, above) were used. (Inset 5.3 describes the method used to calculate the explained variance.) The model for achievement in reading literacy explains 77.8% of variance at level 2 and 44.2% of variance at level 1.

Inset 5.3. Calculation of the Proportion of Explained Variance in Achievement

The method used to calculate the proportion of variance in achievement at level 2 requires one to use a representative value for the size of the level 2 clusters. The mean enrolment size (86.9) of all schools in the PISA sampling frame (the desired population) was used for the representative level 2 cluster size. The formulae used were:

Level 1 R^2 = *1 – (Var L1F + VarL2F)/(VarL1N + VarL2N)*
Level 2 R^2 = *1 – (Var L1F/CS + VarL2F)/(VarL1N/CS + VarL2N)*

Where
VarL1F = Level 1 variance of fitted model
VarL2F = Level 2 variance of fitted model
VarL1N = Level 1 null model variance
VarL2N = Level 2 null model variance
CS = Cluster Size

Contribution of Variables to Achievement in Reading Literacy

The contribution of a number of variables to the linear predictor, with example values, is examined in this section. Example values are required when the parameter estimates cannot be directly translated into units of the response variable (i.e., quadratic fits, and variables involved in interactions). It is also useful to show examples for continuous variables (e.g., disciplinary climate) which are linearly related to the response variable (achievement in reading literacy), even though their parameters do have a direct interpretation. (Inset 5.4 describes how to interpret the parameters from Table 5.7, and how the contribution of continuous explanatory variables is calculated.)

Inset 5.4. Interpreting Model Parameters and Calculating Contributions of Continuous Predictor Variables to Student Achievement

Due to the choice of reference categories for the categorical variables and the use of uncentred continuous variables, the intercept of the final model of reading literacy (479.4) (Table 5.7) is equivalent to the expected score of a *female student* with *low dropout* risk in *grade 10* (fourth year) of a *community or comprehensive school designated as disadvantaged*, who was *absent once or twice* over the two weeks prior to the assessment, so*metimes completes homework on time*, spends *up to 30 minutes per day engaged in leisure reading*, and has a *value of zero on school disciplinary climate, SES and attitudes to reading*. It is possible to examine the effects of variables in any combination on the linear predictor by estimating the contribution of a parameter or combination of parameters.

The model is *additive* in the sense that every variable has an added contribution to the linear predictor. The contribution of categorical variables to the linear predictor are immediately apparent from the final model of achievement. For example, Table 5.7 indicates that:

- A student at risk of dropout is expected to score 54.4 points lower on the PISA reading literacy scale than a student not at risk.
- Students in grade 9 (third year) are expected to score 34.9 points lower than students in grade 10 (fourth year).
- Students in vocational schools have a predicted reading literacy score that is 22.4 points lower than students in community/comprehensive schools.
- Students in schools that are not designated disadvantaged are expected to score 22.3 points higher than students in schools that are designated.

However, the contributions of continuous variables and variables with significant curvilinear trends are not immediately apparent from the final model. It will be recalled from Chapter 4 that continuous variables were categorised into high, medium and low categories using the values corresponding to the 33rd and 67th percentiles on the scales as cut points. The means associated with high, medium and low categories are used in examples of the estimation of the contribution of continuous variables to the linear predictor in this section. For example, to obtain the estimated effect of being in a medium SES group, the parameter estimates from the final model associated with SES and SES squared are multiplied by the desired values of the explanatory variable or *input values* (47 is the value for a medium-SES student, and 2209 is the squared value for medium SES), and summed (see the table below).

Calculation of Contribution of Medium SES to Linear Predictor of Achievement in PISA Reading Literacy

	Parameter	*Value for Medium Group*	*Product*
SES	-0.177901	47	-8.36135
SES Squared	0.009104	2209	20.11070
Sum			*11.74939*

Contribution of Continuous Variables

Student Socioeconomic Status (SES)

Estimates of the contributions of low, medium, and high SES to achievement in reading literacy (Table 5.8; Appendix 5, Table A5.3) indicate that the difference between the estimated scores of students from high and medium SES backgrounds (14.2 points; almost one-sixth of a standard deviation) is larger than the difference between the scores of students from low and medium SES backgrounds (8.8 points; almost one-tenth of a standard deviation). We observe that the relationship is curvilinear because the input values for low and high are equal distances from the middle input value, yet the absolute difference between the high and middle values is greater than the distance between the low and middle values. The difference between expected scores of students from low and high SES backgrounds is 22.9 points (just under one-quarter of a standard deviation).

Table 5.8. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Socioeconomic Status

Level of SES	*Estimated Contributions to Scores*
Low SES	2.97
Medium SES	11.75
High SES	25.90

Number of Siblings

When the estimates of the contribution of increasing numbers of siblings on reading literacy achievement are compared, a strong negative curvilinear relationship is evident (Table 5.9; Appendix 5, Table A5.4). While there is almost no difference in the expected scores of students with no, two and four siblings, students with six siblings are expected to score 21.9 points (around one-fifth of a standard deviation) lower than students with no siblings, and students with eight siblings 48.6 points (half a standard deviation) lower. The upper estimates, however, should be interpreted with caution, since only 8.6% of students had more than four siblings; 2.6% indicated that they had six or seven siblings; and only 0.3% of students had eight siblings or more.

Table 5.9. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Number of Siblings

Number of Siblings	*Estimated Contributions to Scores*
None	0
Two	2.40
Four	–4.90
Six	–21.90
Eight	–48.59

Attitude to Reading

A comparison of the estimates of the contribution of attitude to reading to achievement indicates that having an average attitude to reading makes practically no contribution (–2.1 points; about one-fiftieth of a standard deviation), while the difference associated with contributions of poor and good attitudes is 61.3 points (over three-fifths of a standard deviation) (Table 5.10; Appendix 5, Table A5.5). This is almost three times the difference between the expected contribution of low and high SES students (22.9 points or one-quarter of a standard deviation). The curvilinear nature of the relationship is evident when one compares the difference in the expected contribution to scores in reading literacy between poor and average attitudes (26.4 points, about one-quarter of a standard deviation) with the differences between good and average attitudes (34.9 points; just over one-third of a standard deviation), given the approximately equal spacing of the input values of the explanatory variable.

Table 5.10. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Attitude to Reading

Level of Attitude to Reading	*Estimated Contributions to Scores*
Poor Attitude	–28.53
Average Attitude	–2.12
Good Attitude	32.76

Disciplinary Climate

The difference between the expected contributions to reading literacy achievement of being in a school with a high negative disciplinary climate and one with a low negative disciplinary climate is reflected in an achievement score difference of 27.9 points (over one-quarter of a standard deviation) (Table 5.11; Appendix 5, Table A5.6). This difference is somewhat larger than the expected difference between schools designated as disadvantaged and schools that are not designated (22.3 points; just under one-quarter of a standard deviation) and between secondary and vocational schools (22.2 points) (see Table 5.7).

Table 5.11. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Disciplinary Climate

Level of Disciplinary Climate	*Estimated Contributions to Scores*
Low Negative Climate	14.17
Medium Negative Climate	–0.30
High Negative Climate	–13.69

Index of Books in the Home and Gender

Since the log of the index of books in the home showed a significant interaction with gender (Table 5.12; Appendix 5, Table A5.7) the estimates for the seven values associated with this index are considered for males and females separately.

Table 5.12. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Books in the Home (Log of Books Index), by Gender

	Estimated Contributions to Scores	
Books Index	*Males*	*Females*
No Books (1)	32.17	0
1-10 books (2)	46.22	27.39
11-50 books (3)	54.45	43.44
51-100 books (4)	60.27	43.44
101-250 books (5)	64.79	63.59
251-500 books (6)	68.50	70.80
500+ books (7)	71.62	76.91

For the lowest two categories of the variable, the difference between males and females in expected scores is quite large: 32.2 points (one-third of a standard deviation) for no books, and 18.8 points (one-fifth of a standard deviation) for 1-10 books. This implies that males with few books at home did better on the reading literacy assessment than females with few books. However, as the number of cases in the lowest category is quite small (30 males and 22 females), the results should be interpreted cautiously. As the number of books in the home increases, the gender difference in the estimated contributions decreases such that at the 251-500 category and above, the difference between effects for males and females is reversed, though smaller in magnitude. The variable books in the home appears to be a highly significant predictor of reading achievement for both males and females: females with more than 500 books are expected to score 76.9 points (over three-quarters of a standard deviation) higher than females with no books. The corresponding estimate for males (71.6 points) is similar. For both males and females, the actual and differential effect associated with increased books in the home tapers off at the 101-250 category.

To ensure that this finding was not an artefact of the functional form of the logarithmic scale, an alternative final model using both original and squared terms of the index of books in the home (i.e., the quadratic form) was run. The estimated contributions associated with this model are shown in Table 5.13. Although estimated contributions are slightly different, the substantive conclusions remain the same: males with fewer books in the home do better than females with fewer books in the home; while the opposite holds for students with higher amounts of books at home. The point at which the gender difference for the estimated contributions changes sign from positive to negative is at almost the same point (101-250 books). This suggests that the gender interaction is robust, though the manner in which the data were collected needs to be refined.[41]

Table 5.13. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Books in the Home (Books Plus Books Squared), by Gender

	Estimated Contributions to Scores	
Books Index	*Males*	*Females*
No Books (1)	32.42	12.61
1-10 books (2)	37.96	24.28
11-50 books (3)	43.62	36.42
51-100 books (4)	48.29	44.80
101-250 books (5)	53.08	53.65
251-500 books (6)	57.61	61.56
500+ books (7)	61.90	68.53

Contribution of Some Example Combinations of Variables

In this section, a few of many possible examples of the estimated contributions of some combinations of variables to reading literacy achievement are given. Inferences based on the observed contributions of multiple variables should be made with care since the data are cross-sectional and do not take into account the level of manipulability of variables in the model.

Designated Disadvantaged Status and School Type

In the first example, the estimated contributions to reading literacy achievement of a school with reference to disadvantaged status and type (secondary, vocational, and community/comprehensive) are compared (Table 5.14). It can be seen that the expected

[41]An alternative method for entering books in the home into a model would be to use six dummy-coded variables with the intercept corresponding to the reference category. However the addition of so many extra parameters, especially in the presence of the extra terms required for a significant gender interaction, would make interpretation of the parameter estimates difficult.

contribution of vocational schools which are not designated as disadvantaged is similar to the contribution of secondary and community/comprehensive schools that are designated.

Table 5.14. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Type of School and Disadvantaged Status of School

	Type of School		
Disadvantaged Status	*Secondary*	*Vocational*	*Community/Comprehensive*
Designated	1.80	–20.39	0
Not Designated	24.08	1.89	22.28

Student Dropout Risk and School Type

In the second example, the estimated contributions of student dropout risk and school type (secondary, vocational, and community/comprehensive) are compared simultaneously (Table 5.15). The contribution of students in vocational schools who are at risk of dropout (–74.8 points, over three-quarters of a standard deviation) is noticeably larger than the contribution of at-risk students in secondary schools and community/comprehensive schools (–52.6 points and –54.4 points respectively; over one-half of a standard deviation). Regardless of type of school attended, however, it can be seen that the expected contribution of being at risk of dropout is substantial.

Table 5.15. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Student Dropout Risk and Type of School

	Type of School		
Dropout	*Secondary*	*Vocational*	*Community/Comprehensive*
Yes	–52.59	–74.78	–54.39
No	1.80	–20.39	0

Student Socioeconomic Status (SES) and Attitude to Reading

In the third example, the estimated contributions of SES and attitude to reading are compared simultaneously (Table 5.16). The combined contribution of high SES and a positive attitude to reading is 58.7 points (three-fifths of a standard deviation). The combined contribution of low-SES and a positive attitude is 35.7 points (almost two-fifths of a standard deviation) higher than the combined contribution of high-SES and a negative attitude to reading.

Table 5.16. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Socioeconomic Status and Attitude to Reading

	Attitude to Reading		
Level of SES	*Negative*	*Average*	*Positive*
Low	–25.56	0.85	35.73
Medium	–16.78	9.63	44.51
High	–2.63	23.78	58.66

Development of the Model

Table 5.17 shows the parameters of each level 1 (student level) variable tested separately (see Inset 5.1 for notes on the interpretation of such tables). Note that the log of the index of books in the home rather than the untransformed index was used, as in the model for reading literacy. All coefficients are significant.

All level 1 variables were then entered simultaneously, and non-significant variables removed in sequence. Thus, frequency of absence from school and the parental engagement composite were removed. Unlike the model for reading literacy, the gender difference remains highly significant (t = 6.48; df = 66; p<.001), with males scoring 25.3 points (0.30 of a standard deviation) higher than females. Following the removal of absence from school and parental engagement, the effect of lone parent status was borderline significant (t = –1.74; df = 162; p = .081), but was retained until the model was further refined. The interactions between gender and the other level 1 explanatory variables were then examined by addition to the model separately. Three borderline significant gender interactions emerged: lone parent status (t = 1.94; df = 178; p = .052); frequency of homework completed on time (Ddiff = 6.88; df = 3; p = .076), and log (index of books) (t = –1.75; df = 191; p = .079).

Table 5.17. Achievement in Mathematical Literacy: All Level 1 Variables Tested as Separate Models by Addition to the Null Model

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Gender: Male–Female	11.852	4.693	t = 2.526	100	.012
Socioeconomic Status	1.352	0.123	t = 10.971	186	<.001
Parental Education			Ddiff = 90.340	3	<.001
None/Primary–Upper Sec	–34.534	6.415			
Lower Sec–Upper Sec	–27.046	5.096			
Third Level–Upper Sec	9.637	4.569			
Lone parent: Yes–No	–18.315	5.680	t = –3.225	246	.002
Number of Siblings	–5.604	1.465	t = –3.824	53	.001
Parental Engagement	9.606	2.096	t = 4.584	138	<.001
Log (books index)	72.081	5.294	t = 13.615	552	<.001
Dropout Risk: Yes–No	–72.186	5.252	t = –13.745	306	<.001
Absence			Ddiff = 19.277	2	<.001
No days–1 or 2 days	10.393	3.978			
Three days or more–1 or 2 days	–15.162	6.922			
Homework on Time			Ddiff = 58.745	3	<.001
Never	–26.162	8.679			
Mostly	–23.419	4.467			
Always	12.410	4.566			
Grade Level			Ddiff = 147.477	3	<.001
Grade 8–Grade 10	–110.516	12.913			
Grade 9–Grade 10	–38.157	5.377			
Grade 11–Grade 10	–9.992	6.970			

The three terms were then added simultaneously to the level 1 model. The gender × log (books index) interaction was no longer significant in the presence of the other gender interactions (t = –1.36; df = 248; p = .173); nor was the gender × frequency of homework completed on time interaction (Ddiff = 5.52; df = 3; p = .173). However, the gender × lone parent status interaction retained borderline significance (t = 1.94; df = 178; p = .052), and was retained (Table 5.18 shows the Level 1 model after removal of gender interactions for log (books) and frequency of homework completed on time).

The parameters of each level 2 variable were tested separately by addition to the null model (Table 5.19). All parameters are statistically significant, except for school size. Disciplinary climate is borderline.

As noted in the description of the development of the model of reading literacy, missingness for all level 2 variables was zero, with the exception of student-teacher ratio, and the same non-missing value indicator method was used (see Inset 5.2). After entering all level 2 variables simultaneously, variables were eliminated using the same strategy as with level 1 variables. Thus, school size, school gender composition, non-missing × student-teacher ratio, non-missing for student-teacher ratio, and school disciplinary climate were removed.

Table 5.18. Achievement in Mathematical Literacy: Level 1 Model After Testing for Gender Interactions

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	434.579	11.112			
Gender: Male–Female	22.984	3.915			
Socioeconomic Status	0.715	0.139	t = 5.141	33	<.001
Parental Education			Ddiff = 16.477	3	.001
None/Primary–Upper Sec	–14.349	5.853			
Lower Sec–Upper Sec	–15.390	4.555			
Third Level–Upper Sec	–3.626	4.342			
Lone parent: Yes–No	–18.312	6.622			
Number of Siblings	–3.845	1.363	t = –2.820	31	.009
Log (books index)	48.636	5.062	t = 9.608	738	<.001
Dropout Risk: Yes–No	–55.136	4.962	t = –11.112	518	<.001
Homework on Time			Ddiff = 28.171	3	<.001
Never	–6.902	7.667			
Mostly	–13.645	3.973			
Always	9.943	4.052			
Grade Level			Ddiff = 131.211	3	<.001
Grade 8–Grade 10	–81.990	11.742			
Grade 9–Grade 10	–31.849	4.796			
Grade 11–Grade 10	–2.158	6.343			
Gender × Lone parent	19.149	9.854	t = 1.943	178	.052
Variance Components					
Level 2 Variance	171.431		χ^2 = 220.268	138	<.001
Level 1 Variance	4250.786				
Variables Dropped from Model (In Sequence)					
Absenteeism					
Parental Engagement					
Gender × Log (Books Index)					
Gender × Homework on Time					

Following removal of non-significant level 2 variables, the curvilinearity of all continuous variables remaining in the model (i.e., socioeconomic status and number of siblings at level 1, and no variables at level 2 since disciplinary climate, the only continuous variable at that level, was not significant) was tested. Neither socioeconomic status nor number of siblings displayed a significant curvilinear trend. The final step was to test level 1 variables for significant random variation across schools. None was significant. Therefore, the final model of achievement in mathematical literacy (Table 5.20) does not contain any quadratic terms or random slopes.

Table 5.19. Achievement in Mathematical Literacy: All Level 2 Variables Tested As Separate Models by Addition to the Null Model

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Disciplinary Climate	–15.102	7.743	t = –1.950	137	.051
School Type			Ddiff = 28.013	2	<.001
Secondary–Comm, Comp	15.395	7.768			
Vocational–Comm, Comp	–19.344	9.342			
Not designated disadv-Designated disadv	33.008	6.095	t = 5.415	137	<.001
School Gender Composition			Ddiff = 15.842	2	<.001
All Males–All Females	30.187	7.597			
Co–educational–Mixed Sex	3.675	6.757			
School Size (Number of 15–Year Olds)			Ddiff = 3.137	2	.208
Large–Medium	5.178	13.759			
Small–Medium	11.702	6.940			
Student–Teacher Ratio	4.183	1.499	t = 2.790	136	.006

Table 5.20. Final Model of Achievement in Mathematical Literacy With Gender × Lone Parent Interaction

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	425.444	12.021			
Student-Level Variables					
Gender	23.943	3.797			
Socioeconomic Status	0.658	0.138	t = 4.723	35	<.001
Parental Education			Ddiff = 14.248	3	.003
None/Primary–Upper Sec	–13.725	5.821			
Lower Sec–Upper Sec	–14.216	4.601			
Third Level–Upper Sec	–4.060	4.306			
Lone parent: Yes–No	–18.034	6.601			
Lone parent × Gender	18.682	9.777	t = 1.911	194	.056
Number of Siblings	–3.636	1.367	t = –2.659	29	.013
Log (books index)	47.761	5.053	t = 9.453	661	<.001
Dropout Risk: Yes–No	–53.662	4.931	t = –10.882	646	<.001
Homework on Time			Ddiff = 28.025	3	<.001
Never	–6.601	7.634			
Mostly	–13.203	3.937			
Always	10.266	4.004			
Grade Level			Ddiff = 133.692	3	<.001
Grade 8–Grade 10	–79.443	11.643			
Grade 9–Grade 10	–31.465	4.721			
Grade 11–Grade 10	–0.212	6.238			
School-Level Variables					
School Type			Ddiff = 10.719	2	.005
Secondary–Comm, Comp	5.234	5.499			
Vocational–Comm, Comp	–9.794	6.671			
Not designated disadv-Designated disadv	12.340	4.511	t = 2.736	135	.007
Variance Components					
Level 2 Variance	113.811		χ^2 = 191.792	132	.001
Level 1 Variance	4237.372				
Variables Dropped from Model (In Sequence)	School Gender Composition				
Absenteeism	Non-missing × Student-Teacher Ratio				
Parental Engagement	Non-Missing Indicator for Student-Teacher Ratio				
School Size	Disciplinary Climate				
Gender × Log (Books Index)					
Gender × Homework on Time					

Because the gender × lone parent interaction is of borderline significance, an alternative model that omits the interaction term is presented in Appendix 5 (Table A5.8). As noted above, the method used to calculate the proportion of variance in achievement at level 2 requires one to use a representative value for the size of the level 2 clusters (see Inset 5.3). The percentage of between-school variance explained by the final mathematical literacy model (Table 5.20) is 78.8%, and the percentage of explained within-school variance is 31.9%.

Contribution of Variables to Achievement in Mathematical Literacy

The contribution of a number of variables to the linear predictor, with example values, is described in this section. (Inset 5.4 describes how to interpret the parameters from Tables such as 5.20, and how the contribution of continuous explanatory variables is calculated.)

Contribution of Continuous Variables

Socioeconomic Status (SES)

Estimates of the contributions of low, medium, and high SES (Table 5.21; Appendix 5, Table A5.9) indicate that the difference between the estimated scores of students from high and medium SES backgrounds is 10.9 points (about one-eighth of a standard deviation); and the difference between the scores of students from low and medium SES backgrounds, at 10.9 points, is identical.

Table 5.21. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Socioeconomic Status

Level of SES	*Estimated Contributions to Scores*
Low SES	20.06
Medium SES	30.84
High SES	41.71

Number of Siblings

When the estimates of the contribution of increasing numbers of siblings to mathematical literacy achievement are compared, it can be observed that with each addition of two siblings, achievement is expected to decrease by 7.2 points, such that the expected contribution of six siblings is –21.7 points (around one-quarter of a standard deviation) compared with no siblings (Table 5.22; Appendix 5, Table A5.10).

Table 5.22. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Number of Siblings

Number of Siblings	*Estimated Contributions to Scores*
None	0
Two	–7.22
Four	–14.44
Six	–21.66
Eight	–28.88

Index of Books in the Home

In contrast to the model for reading literacy, no significant gender interaction was associated with the log of the index of books in the home. Estimates of the contribution of each of the seven values of the index indicate that the books in the home is a powerful predictor of achievement in mathematical literacy, with a difference of 93.4 points (over one standard deviation) between the expected score of students with no books and the expected score of students with 500 books or more in their homes (Table 5.23; Appendix 5; Table A5.11). The differences between successive categories decrease somewhat (from 37.3 points to 7.4 points) indicating curvilinearity in the trend.

Table 5.23. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Books in the Home

Books Index	*Estimated Contributions to Scores*
No Books (1)	0
1-10 books (2)	37.26
11-50 books (3)	52.72
51-100 books (4)	66.52
101-250 books (5)	77.23
251-500 books (6)	85.98
500+ books (7)	93.38

Lone Parent Status and Student Gender

An examination of the interaction between lone parent status and student gender (Table 5.24; Appendix 5, Table A5.12) reveals no difference (less than one score point) in the expected scores of males living in lone parent families and males not living in lone parent families. However, the expected contribution of living in a lone parent family for females is –18.0 points (one-fifth of a standard deviation). Thus, the magnitude of the gender gap varies, with females performing more poorly than males in both types of family structure, but comparatively worse (42.6 points lower or half a standard deviation) in lone parent families.

Table 5.24 also shows the expected contributions of gender and lone parent status to achievement in the alternative model which excludes the gender interaction (Appendix 5, Table A5.8). It can be seen that being male contributes significantly more than being female, and that the magnitude of the gender difference (26.2 points; 0.31 of a standard deviation) remains constant across lone parent status when no interaction term is included.

Table 5.24. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Lone Parent Status, by Gender

	Estimated Contributions to Scores	
Lone Parent Status	*Males*	*Females*
Model With Gender Interaction		
Lone parent	24.59	–18.03
Not Lone parent	23.94	0
Model Without Gender Interaction		
Lone parent	17.56	–8.65
Not Lone parent	26.21	0

Contribution of Some Example Combinations of Variables

In this section, two examples of the estimated contribution of some combinations of variables are presented. Many more combinations are, of course, possible.

Designated Disadvantaged Status and School Type

In the first example, the estimated contribution of the disadvantaged status and type (secondary, vocational, and community/comprehensive) of school attended by the student are compared (Table 5.25). The expected contribution of vocational schools that are not designated as disadvantaged is broadly similar to the expected contribution of secondary and community/comprehensive schools that are designated. The largest difference is between the combined contribution of secondary non-designated schools and vocational designated schools (27.4 points; one-third of a standard deviation).

Table 5.25. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Type of School and Disadvantaged Status of School

		Type of School	
Disadvantaged Status	*Secondary*	*Vocational*	*Community/Comprehensive*
Designated	5.23	–9.79	0
Not Designated	17.57	2.55	12.34

Student Socioeconomic Status and Disadvantaged Status of the School

In the second example, the combined contribution of student SES and disadvantaged status of the school being attended are compared (Table 5.26). The contribution of medium SES and designated school (30.8 points, over one-third of a standard deviation) is similar to the contribution of low SES and non-designated school (32.4 points); similarly, the contribution of a high SES and designated school (41.7 points; about half a standard deviation) is similar to the contribution of medium SES and non-designated school (43.2 points). The largest difference in expected scores is that between high-SES students in non-designated schools and low-SES students in designated schools (34.0 points; two-fifths of a standard deviation).

Table 5.26. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Student Socioeconomic Status and Type of School

		Level of SES	
Disadvantaged Status	*Low*	*Medium*	*High*
Designated	20.06	30.84	41.71
Not Designated	32.40	43.18	54.05

MODEL OF SCIENTIFIC LITERACY

Development of the Model

Table 5.27 shows the parameters of each level 1 (student level) variable tested separately (see Inset 5.1 for notes on the interpretation of tables). Note that the log of the index of books in the home rather than the untransformed index was used again. All coefficients are significant with the exception of gender.

All level 1 variables were entered simultaneously. The non-significant variables were removed in sequence, and the significance of variables retained in the model re-evaluated each time. Lone parent status is not significant and was removed (t = –.043; df = 433; p = .966). As in the case of the model of reading literacy, the gender difference is not significant in the presence of the other level 1 variables (t = 6.79; df = 353; p = .138), but gender is retained in the model to test for significant gender interactions. Following the removal of lone parent status, all remaining level 1 variables (apart from gender) remain significant, with the exception of parental education, which, though borderline (Ddiff = 6.87; df = 3; p = .076), was retained pending further refinement of the model.

Table 5.27. Achievement in Scientific Literacy: All Level 1 Variables Tested as Separate Models by Addition to the Null Model

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Gender: Male–Female	–5.192	5.047	t = –1.029	431	.304
Socioeconomic Status	1.482	0.126	t = 11.720	1412	<.001
Parental Education			Ddiff = 78.632	3	<.001
None/Primary–Upper Sec	–28.787	7.120			
Lower Sec–Upper Sec	–15.581	5.351			
Third Level–Upper Sec	21.885	5.118			
Lone parent: Yes–No	–13.156	6.189	t = –2.126	414	.033
Number of Siblings	–8.333	1.429	t = –5.833	795	<.001
Parental Engagement	15.356	2.181	t = 7.042	240	<.001
Log (books index)	77.102	5.428	t = 14.206	193	<.001
Dropout Risk: Yes–No	–88.078	5.628	t = –15.650	442	<.001
Absence			Ddiff = 31.885	2	<.001
No days–1 or 2 days	10.988	4.388			
Three days or more–1 or 2 days	–26.496	7.876			
Homework on Time			Ddiff = 57.118	3	<.001
Never	–55.366	9.068			
Mostly	–21.698	5.335			
Always	3.438	4.711			
Grade Level			Ddiff = 128.226	3	<.001
Grade 8–Grade 10	–106.087	13.129			
Grade 9–Grade 10	–42.340	6.090			
Grade 11–Grade 10	–12.610	7.509			
Studies Science: Yes–No	59.605	7.230	t = 8.244	88	<.001

The interactions between gender and the other level 1 explanatory variables were examined by addition to the model separately. Two significant gender interactions emerged (one borderline): frequency of absence from school (Ddiff = 4.76; df = 2; p = .093); and log of the index of books in the home (t = 7.50; df = 332; p<.001). The two interaction terms were then added simultaneously to the level 1 model. The gender × absence interaction is no longer significant in the presence of the other gender interaction (Ddiff = 4.17; df = 2; p = .124). However, the gender × log (books index) interaction remains highly significant (t = –3.18; df = 1970; p = .002), and was retained. With the addition of gender × log (books index), level of parental education is no longer significant (Ddiff = 6.04; df = 3; p = .110), and was removed from the model (Table 5.28).

The parameters of each level 2 variable were each tested separately by addition to the null model (Table 5.29). All parameters are statistically significant, except for school size (the number of 15-year olds enrolled, the explicit stratifying variable used in the sample design).

Table 5.28. *Achievement in Scientific Literacy: Level 1 Model After Testing for Gender Interactions*

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	384.959	15.684			
Gender: Male–Female	59.925	16.275			
Socioeconomic Status	0.759	0.118	t = 6.409	648	<.001
Number of Siblings	–5.532	1.267	t = –4.366	364	<.001
Parental Engagement	5.537	2.022	t = 2.739	126	.007
Log (books index)	64.433	8.035			
Log (books index) x Gender	–34.112	10.079	t = –3.385	1975	.001
Dropout Risk: High–Low	–59.654	5.589	t = –10.673	241	<.001
Absence			Ddiff = 12.441	2	.002
No days–1 or 2 days	6.152	3.867			
Three days or more–1 or 2 days	–14.297	6.967			
Homework on Time			Ddiff = 95.636	3	<.001
Never	–26.704	8.566			
Mostly	–7.163	4.694			
Always	0.357	4.499			
Grade Level			Ddiff = 13.182	3	.004
Grade 8–Grade 10	–65.476	12.156			
Grade 9–Grade 10	–32.959	5.312			
Grade 11–Grade 10	–2.517	6.536			
Studies Science: Yes–No	42.940	6.597	t = 6.509	55	<.001
Variance Components					
Level 2 Variance	5118.109		χ^2 = 299.676	138	<.001
Level 1 Variance	413.097				
Variables Dropped from Model (In Sequence)					
Lone parent Status					
Absence x Gender					
Parental Education					

Table 5.29. *Achievement in Scientific Literacy: All Level 2 Variables Tested Separately by Addition to the Null Model*

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Disciplinary Climate	–22.316	9.124	t = –2.446	137	.015
School Type			Ddiff = 45.354	2	<.001
Secondary–Comm, Comp	26.200	9.093			
Vocational–Comm, Comp	–25.257	10.658			
Not designated disadv-Designated disadv	46.737	7.621	t = 6.133	137	<.001
School Gender Composition			Ddiff = 10.770	2	.005
All Boys–All Girls	24.939	9.633			
Co-educational–Mixed Sex	20.647	8.021			
School Size (Number of 15–Year Olds)			Ddiff = 3.730	2	.155
Large–Medium	–1.584	16.806			
Small–Medium	14.283	8.234			
Student–Teacher Ratio	5.962	1.774	t = 3.361	136	.001

As noted in the descriptions of the development of the models of reading and mathematical literacy, missingness for all level 2 variables was zero, with the exception of student-teacher ratio, and the same non-missing value indicator method was used (see Inset 5.2). After entering all level 2 variables simultaneously, variables were eliminated using the same strategy as with level 1 variables. Thus, school size, school gender composition, non-missing × student-teacher ratio, non-missing for student-teacher ratio, and school disciplinary climate were removed.

Following removal of non-significant level 2 variables, the curvilinearity of all continuous variables remaining in the model (socioeconomic status, parental engagement, and number of siblings at level 1, and no variables at level 2 as disciplinary climate is not significant), was tested. None of the three variables displayed a significant curvilinear trend. The final step was to test level 1 variables for significant random variation across schools. None was significant. Therefore, the final model of achievement of scientific literacy (Table 5.30), like the final model for mathematical literacy, does not contain any quadratic terms or random slopes.

The method used to calculate the proportion of variance in achievement at level 2 requires one to use a representative value for the size of the level 2 clusters (see Inset 5.3). The percentage of between-school variance explained by the model is 74.5%, and the percentage of explained within-school variance is 34.1%.

Table 5.30. Final Model of Achievement in Scientific Literacy

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	370.462	17.014			
Student Level Variables					
Gender	59.438	16.149			
Socioeconomic Status	0.679	0.117	t = 5.781	1090	<.001
Number of Siblings	–4.943	1.270	t = –3.893	310	<.001
Parental Engagement	5.207	2.009	t = 2.591	125	.010
Log (books index)	62.690	8.001			
Log (books index) x Gender	–33.304	10.025	t = –3.322	1972	.001
Absence			Ddiff = 11.913	2	.003
No days–1 or 2 days	6.091	3.841			
Three days or more–1 or 2 days	–13.751	6.923			
Dropout Risk	–57.478	5.595	t = –10.273	222	<.001
Homework on Time			Ddiff = 12.993	3	.005
Never	–26.353	8.524			
Mostly	–6.662	4.652			
Always	0.908	4.487			
Grade Level			Ddiff = 98.898	3	<.001
Grade 8–Grade 10	–63.216	12.017			
Grade 9–Grade 10	–31.778	5.213			
Grade 11–Grade 10	0.723	6.444			
Studies Science: Yes–No	43.104	6.479	t = 6.653	57	<.001
School Level Variables					
School Type			Ddiff = 17.112	2	<.001
Secondary–Comm, Comp	10.587	6.758			
Vocational–Comm, Comp	–12.528	8.019			
Not designated disadv-Designated disadv	17.610	5.363	t = 3.283	135	.001
Variance Components					
Level 2 Variance	257.406		χ^2 = 241.736	135	<.001
Level 1 Variance	5105.357				

Variables Dropped from Model (In Sequence)	
Lone parent Status	School Size
Absence x Gender	School Gender Composition
Parental Education	Non–missing x Student–Teacher Ratio
	Non–Missing Indicator for Student–Teacher Ratio
	Disciplinary Climate

Contribution of Variables to Achievement in Scientific Literacy

The contribution of a number of variables to the linear predictor, with example values, is examined in this section. (Inset 5.4 describes how to interpret the parameters from Tables such as 5.30, and how the contribution of continuous explanatory variables is calculated.)

Contribution of Continuous Variables

Socioeconomic Status (SES)

Estimates for the contributions of low, medium, and high SES (Table 5.31; Appendix 5, Table A5.13) indicate that the differences between the estimated scores of students from high and medium SES backgrounds (11.3 points or about one-eighth of a standard deviation) and between the scores of students from low and medium SES backgrounds (11.7 points) are almost identical.

Table 5.31. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Socioeconomic Status

Level of SES	*Estimated Contributions to Scores*
Low SES	20.33
Medium SES	31.97
High SES	43.33

Number of Siblings

When the estimates of the contribution of increasing numbers of siblings on scientific literacy achievement are compared, it can be observed that with the addition of every two siblings, achievement is expected to decrease by about 10 points, such that the contribution of four siblings is 19.8 points (just over one-fifth of a standard deviation) (Table 5.32; Appendix 5, Table A5.14).

Table 5.32. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Number of Siblings

Number of Siblings	*Estimated Contributions to Scores*
None	0
Two	–9.89
Four	–19.77
Six	–29.66
Eight	–39.54

Parental Engagement

Estimates for the contributions of low, medium, and high levels of parental engagement (Table 5.33; Appendix 5, Table A5.15) to scientific literacy achievement indicate that the difference between the estimated scores of students with high and medium levels of parental engagement is 5.7 points, and the difference between the scores of students with low and medium parental engagement is 4.7 points. Thus, the difference between the expected contributions of high and low levels is only around one-tenth of a standard deviation. These estimates are smaller than those for SES and, while they may be statistically significant, are probably not of substantive importance.

Table 5.33. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Parental Engagement

Level of Parental Engagement	*Estimated Contributions to Scores*
Low Engagement	–6.21
Medium Engagement	–0.56
High Engagement	4.15

Index of Books in the Home and Gender

Since the log of the index of books in the home showed a significant interaction with gender for scientific literacy (as well as for reading literacy), the estimates for the seven values associated with this index are considered for males and females separately (Table 5.34; Appendix 5, Table A5.16).

For the lowest two categories of the variable, the gender difference in the contribution to student achievement is quite large: 59.4 points (three-fifths of a standard deviation) for no books, and 36.4 points (almost two-fifths of a standard deviation) for 1-10 books. This implies that males with few books at home did substantially better on the scientific literacy assessment than females with few books at home. As the number of books in the home increases, the gender difference in the estimated contributions decreases so that at the 251-500 category and above, the difference between effects for males and females is reversed, though considerably smaller in magnitude. The variable books in the home appears to be an important predictor of achievement in scientific literacy, particularly for females: females with more than 500 books are expected to score 122.0 points (one-and-a-quarter standard deviations) higher than females with no books. The corresponding figure for males (59.4 points; almost two-thirds of a standard deviation) is still large, though considerably smaller than for females.

Table 5.34. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Books in the Home (Log of Books Index), by Gender

	Estimated Contributions to Scores	
Books Index	*Males*	*Females*
No Books (1)	59.44	0
1-10 books (2)	79.81	43.45
11-50 books (3)	91.72	68.87
51-100 books (4)	100.18	86.91
101-250 books (5)	106.73	100.90
251-500 books (6)	112.09	112.33
500+ books (7)	116.62	121.99

Contribution of Combinations of Variables

In this section, two examples of the estimated contribution of some combinations of variables are given. Many other combinations are possible.

Designated Disadvantaged Status and School Type

In the first example, the estimated contribution of school with reference to type (secondary, vocational, and community/comprehensive) and disadvantaged designation is described (Table 5.35). The contribution of vocational schools that are not designated as disadvantaged is broadly similar to the contribution of community/comprehensive schools that are designated. The largest difference in the combined contribution is between secondary non-designated schools and vocational designated schools (40.7 points).

Table 5.35. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Type of School and Disadvantaged Status of School

		Type of School	
Disadvantaged Status	*Secondary*	*Vocational*	*Community/Comprehensive*
Designated	10.59	–12.53	0
Not Designated	28.20	5.08	17.61

Frequency of Homework Completed on Time and Study of Science

In the second example, the estimated contribution of studying/not studying science at Junior Cycle level and frequency of completing homework on time is described (Table 5.36). Studying science and completing homework mostly or always on time contributes over 43 points (almost half a standard deviation) to achievement in scientific literacy. The difference between the expected contribution of never completing homework on time and not studying science, and always completing homework on time and studying science, at 70.4 points (three-quarters of a standard deviation), is substantial.

Table 5.36. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Whether or Not Students Study Science and Frequency of Completion of Homework on Time

	Frequency of Completion of Homework on Time			
Studies Science	*Never*	*Sometimes*	*Mostly*	*Always*
Yes	16.75	36.44	43.10	44.01
No	-26.35	-6.66	0	0.91

SUMMARY AND IMPLICATIONS OF THE MODELS

Reading Literacy

Although the simultaneous inclusion of level 1 variables in the intermediate model resulted in no significant gender difference, one cannot conclude from the final model that the gender difference is not significant, given the presence of the log (index of books) × gender interaction. The pattern in the observed data for crosstabulation of both explanatory variables (Appendix 4, Table A4.9) is consistent with the pattern found in the more complex analyses reported here: at the lowest level (no books), males score higher than females, though not significantly so; and females score significantly higher than males in the '51-100' category and in all categories above that point. Hence the point at which the sign of the gender difference changes is lower on the scale in the observed data crosstabulation than was the case in the hierarchical linear model, though the latter is a model that contains a variety of additional explanatory variables not taken into account in the observed data crosstabulation. The finding that females do not do consistently better than males once the variable books in the home is taken into account has not been explored widely in previous research, and is worthy of further investigation. As noted in Appendix 4, Table A5.9, the correlation between the books index and achievement in reading literacy of males (.28) is lower than that for females (.37), a finding which differs from that reported by Wagemaker (1996) for Irish 14-year olds (correlations between achievement on the narrative scale and books in the home were .26 for males and .19 for females). While Wagemaker's analyses suggest that the slope of the relationship between books in the home and reading literacy achievement is steeper for males than for females, Irish data from PISA suggest the opposite.

The model also demonstrates that school-level features (school climate, school type, and disadvantaged status) have a significant impact on students' reading literacy achievement, over and above aspects of their home background, attitude to reading, frequency of leisure reading, risk of dropout, grade level, absenteeism, and homework practices. The fact that just three school-level variables, two of them structural, explain such a high percentage of between-school variance (77.8%) suggests a need to further examine how students select schools, how schools select students, and the effects of selection on student achievement.

The finding that the effects of dropout risk on achievement vary across schools, together with the fact that students at risk of dropout score, on average, over half a standard deviation lower than students not at risk, suggests that the early identification of such students, and of school factors associated with the risk of dropout, are important areas for future research and policy intervention.

The significant interaction between gender and the index of books in the home indicates that males with fewer books at home do better than females with fewer books, while the trend is reversed with higher amounts of books at home (females do better). This finding could partly be due to the manner in which data on books in the home were collected: the top category is unbounded, and the intervals are not equivalent. Further, there are relatively few cases in the lowest category. Future studies examining relationships between books in the home and achievement could help explain this finding through more sensitive measures (for example, by asking students to write the actual number of books, and to describe the types of reading material available to them at home). Similarly, the paradoxical effect of attitude to reading on the effects of the frequency of leisure reading needs to be further examined, possibly through the collection of data on the frequency with which students read various types of text, both in school (or as part of their homework and study) and in their leisure time.

Mathematical Literacy

The final model of mathematical literacy indicates that gender differences in achievement vary according to whether or not students live in lone parent families. There is no difference for males in the expected contribution of lone parent and non-lone parent households. Living in a lone parent family for females, however, is associated with a score reduction of about one-fifth of a standard deviation.

The magnitude of the parameter estimate for dropout risk for mathematical literacy (–53.7) is particularly large. Level of parental education is also a significant predictor of achievement in mathematical literacy, though it was not found to be so for reading literacy. The index of books in the home strongly predicts achievement in mathematical literacy; the difference between expected contributions of the highest and lowest points on the index is more than one standard deviation.

Just two school-level variables, school type and designated disadvantaged status, explain over 70% of variance between schools (the model of reading literacy contains an additional variable, disciplinary climate).

Scientific Literacy

The final model of scientific literacy includes a significant gender interaction with log (index of books), which makes interpretation somewhat complex, and suggests that gender differences in achievement in scientific literacy vary by the number of books in the home. As mentioned earlier in the context of the model of reading literacy, further research into the nature of this interaction is required.

The magnitude of the parameter estimate associated with dropout risk (–57.5) is very similar to the estimates for both reading and mathematical literacy. The parameter estimate indicating whether or not a student studied science, when entered on its own (59.6; Table 5.26). did not decrease substantially after addition of level 1 and 2 variables (43.1; Table

5.29). This suggests that the poorer performance of Irish students on the scientific literacy assessment relative to their performance on the assessment of reading literacy may be due in large part to a lack of exposure of some students to science in school.

It may seem strange to note that parental engagement was a significant predictor of achievement in scientific literacy, but not of achievement in reading or mathematical literacy. However, the difference in the expected contributions to scores of students with high and low parental engagement (10.4 points) is relatively small compared with other variables in the model (such as dropout risk, study of science, or SES) once other variables in the model are accounted for.

The same two school-level variables (school type and designated disadvantaged status) used in the model of mathematical literacy explained over 70% of variance between schools in achievement in scientific literacy.

CONCLUSION

In an examination of between-school variance in achievement, it was found that the percentages of total variance that lie between schools in Ireland (17.8% for reading literacy; 11.4% for mathematical literacy; and 14.1% for scientific literacy) are lower than previous studies would have suggested. For example, in IEA/RLS, the percentage associated with reading achievement was 48 (Postlethwaite, 1995); and in TIMSS, it was 50% for mathematics and 38% for science (Martin et al., 2000). The values in the present study are closer to the value (22%) obtained by Smyth (1999) in her study of the performance of students on the Junior Certificate Examination (in which the outcome variable was a composite that summarised performance in six examination subjects). However, unless sampling procedures and the outcome measure are the same or similar across studies, *direct* comparisons of variance components associated with different studies cannot be made. In this context, it will be noted that while the sample design for PISA was age-based, and included 15-year olds from four grade levels in Ireland, the sample designs for both IEA/RLS and TIMSS were grade-based.[42]

Hierarchical linear models were presented for reading literacy, mathematical literacy, and scientific literacy. All three models explain over 74% of between-school variance. The model of reading literacy explains 44.2% of within-school variance, and the models of mathematical and scientific literacy explain 31.9% and 34.1% of within-school variance, respectively. The inclusion of two variables specific to reading habits and attitudes (frequency of leisure reading and attitude to reading) in the model of reading literacy may account for the slightly higher proportion of within-school variance explained in this domain.

The fact that in all three subject areas, the same two school-level variables (school type and disadvantaged status) – in conjunction with a number of key student-level variables including socioeconomic status (SES) and family size - explain such a high proportion of the between-school variance would seem to have implications for the way students are distributed across schools. Interpretation is complex, however, and the data available in the present study do not, of course, allow an estimation of the impact of variables on achievement over time.

Because mathematics and science were minor domains in PISA 2000, the sample sizes associated with them were relatively small (about five-ninths the size of the sample for reading literacy). As a result, the models for mathematical and scientific literacy are simpler than the one for reading literacy (e.g., no significant curvilinear trends in many continuous

[42] Because TIMSS and IEA/RLS designs were grade-based, some of the between-classroom variance is incorporated into the estimates of between-school variance. In TIMSS, different sampling methods were used for mathematics and science, so the two sets of variance components are not directly comparable with one another (Adams, personal communication).

variables). A richer and more complex picture of performance in both literacy domains may be expected when they are the major assessment domains (mathematics in 2003, and science in 2006).

A binary variable measuring students' dropout risk is highly significant in all three models, in all of which the predicted scores of students at risk of dropping out prior to completing the Senior Cycle at second level are more than half a standard deviation below the scores of students not at risk. Further, the effects of dropout risk vary randomly across schools in the model of reading literacy. Not only do high-risk students have poorer educational outcomes in the short term, their quality of life in the longer term may also be expected to suffer (see Morgan et al., 1997). Clearly, the early identification of such students and the development of procedures to deal with early school leaving are issues that require attention.

In all three models, the books in the home variable is highly significant. It is reasonable to assume that the index of books in the home is a good proxy for home educational climate, and in fact, as was shown in Chapter 4, it is more closely related to achievement than the composite measure of home educational resources (see Table 4.46). For both the reading and scientific literacy models, a significant interaction between gender and the measure of the amount of books in the home was found. When estimates of the contributions of various values on the index of books for males and females to reading and scientific literacy are examined, a pattern emerges, in which females with fewer books do less well than males with fewer books in both domains, however at higher points on the index, differences favour females, though the magnitude of the difference is smaller. The same pattern was observed in the less complex crosstabulation of gender by books in the home reported in Appendix 4, Table A4.11. Problems in the manner in which the number of books in the home was measured point to the need for further research using improved measures to explore further the nature of this gender interaction.

When attitude to reading was added to models of reading literacy containing frequency of leisure reading as the explanatory variable, the sign of the highest frequency of leisure reading becomes negative. This suggests that, once attitudes are taken into account, a higher amount of time spent reading during leisure time is no longer positively associated with reading literacy achievement.

Males performed better than females on the mathematical literacy assessment. Furthermore, the scores of males were not associated with lone parent status. However, the expected score of females in lone parent families is about one-fifth of a standard deviation lower than the score of females who do not live in lone parent families.

In the model of scientific literacy, students who do not study science in school had an expected score that is about one-quarter of a standard deviation lower than students who study science. The poorer performance of students in scientific literacy compared with reading literacy may be due in large part to the fact that around 11% of Irish students who participated in PISA did not study science in school. If this is so, the possibility of broadening the availability of science as a subject at Junior Cycle level may need to be considered.

Given the extensive literature on the relationship between socioeconomic background and achievement, it is not surprising that SES predicted achievement in all three models. However, the magnitude of difference in the expected contributions of high SES and low SES, is smaller than, or about the same as, other estimated contributions, such as dropout risk, frequency of absence from school, books in the home, attitude to reading (in the case of reading literacy), and completion of homework on time. And while such variables are likely to be inter-related with SES in a complex manner, it is clear that aspects of students' environments other than those represented by this simple measure of SES are important in explaining student achievement in reading, mathematical and scientific literacy.

6

Curriculum and Assessment in Ireland and Performance on PISA

The purpose of this chapter is twofold: to examine the relationship between the performance of Irish 15-year olds on the Junior Certificate Examination and their performance on PISA, and to examine the relationship between the expected familiarity of Irish students with items in the assessment and their performance on PISA. Before addressing these issues, the Junior Certificate syllabi in English, Mathematics, and Science that were current at the time of the PISA assessment, and the performance of students in these three subjects in the Junior Certificate Examination, will be described.

JUNIOR CYCLE ENGLISH

Current Issues in English Reading Literacy Education in Ireland

The Irish government considers the creation and maintenance of a highly literate population to be a priority in the interests of social and economic well-being. In its White Paper on Education *(Charting Our Education* Future, 1995), it is stated that

> A significant minority of students do not acquire satisfactory levels of literacy or numeracy while at primary school…. The revised [primary school] curriculum will place particular emphasis on overcoming this problem. The objective will be to ensure that, having regard to the assessment of their intrinsic abilities, there are no students with serious literacy and numeracy problems in early primary education in the next five years. (p. 20)

The efforts of the government, through the Department of Education and Science, to eliminate serious literacy problems, are evidenced in improvements in literacy-related resources in recent years. For example, the number of library books per pupil in primary schools almost doubled between 1993 and 1998, and schools are now better resourced by learning support teachers (Cosgrove et al., 2000). The launch of the National Reading Initiative (budget: £2.5 million; 3.18 Euro) in 2000 (Department of Education and Science, 2000a) is perhaps the most broad-ranging and strategic government intervention to date in this area. The initiative employed both curative and preventative strategies. It aimed both to eliminate serious literacy problems in children and adults and also to promote awareness in the general public of the importance of literacy. Concurrent with the initiative, the Department has set up a task force on dyslexia. Other government interventions aimed at ameliorating literacy problems include programmes for students from disadvantaged backgrounds such as *Breaking the Cycle* (Department of Education, 1996b).

English Syllabus and Assessment

To provide a context for interpreting student outcomes on the PISA assessment of reading literacy, the English syllabus and its assessment at Junior Cycle are described. Where possible, comparisons between PISA and the national syllabus are made. Teacher guidelines, past Junior Certificate Examination papers, and the Chief Examiner's report of Junior Certificate English are also considered, since they can also provide insights into the approach taken to the teaching of English and the elements of reading literacy which are emphasised (Department of Education, n.d.; Department of Education, 1994; NCCA, n.d.). The section focus is on the syllabus at Junior Cycle rather than at Senior Cycle because most 15-year olds (over 80%) are still in Junior Cycle (Department of Education and Science,

2000) and less than 1% of the 15-year olds who participated in PISA had completed more than one year of the Senior Cycle at the time of the PISA assessment.[43]

In the current Junior Certificate English syllabus, a distinction is made between *personal*, *social*, and *cultural* literacies, thus echoing the multiple functions (functional, reflective) and contexts (private, public, educational and occupational) of reading evident in the PISA definition of reading literacy (see Chapter 1). The inter-relationships between the individual, his or her understanding and expression of aesthetic text forms, ability to understand, use and produce public, functional texts, and personal development through linguistic expression, are recognised in the syllabus. Distinctions are made between texts based on their intended purposes and audiences. The development of criticism and persuasion, as well as reading and listening strategies, is fostered. The use of a diversity of texts in instruction is mentioned a number of times. Teachers are not bound to teach only those texts which are included in the syllabus for examination, and are encouraged to select texts which are appropriate to the cultural environment, stage of development, and linguistic abilities of their students. They are also encouraged to use 'syllabus units' in their class planning, defined as 'an interrelated selection of literary texts, cultural materials and linguistic assignments which provide the substance, purpose and direction to work in the English programme for a period of time' (Department of Education, n.d., p. 5). A holistic and integrated approach is thus emphasised, as a unit is built around a central theme. Teacher guidelines specify a list of targets and activities for each of the three years of the Junior Cycle for the strands of language, literature, oral, aural, reading, and writing skills (summarised in Table 6.1). The targets and activities suggest that, by the end of the cycle, students of average or above average ability should have a well-developed set of skills and techniques for the critical reading, writing, and analysis of the structure, form, style, and tone of many different text types.

Formal assessment of the Junior Certificate English syllabus is in the form of written examination at three levels: Higher, Ordinary, and Foundation. The teacher guidelines do not differentiate between Higher and Ordinary levels, while guidelines for Foundation level have not been published. A recent survey of second-level principals (NCCA, 1999, Appendix III) indicated that the Junior Cycle in general is thought to be more suitable for, amongst others, hardworking or average and above-average students, and less suitable for educationally disadvantaged students, those with learning disabilities, students at risk of dropping out, and adult students. While it has been suggested by the NCCA that Junior Certificate English does not target low achievers and is not suitable for weak ability students, by contrast, the wide range of item difficulties in the PISA assessment suggests that students with varying levels of literacy will be capable of attempting some questions.

Students are asked to respond to both unseen and familiar (course-specific) material in the Junior Certificate Examination. Coursework includes studying a prescribed set of poems, short stories, plays, and novels. Both modern and classic texts are included from a variety of (mostly) English-speaking cultures. At Ordinary level, students are assessed in the following areas (Department of Education and Science, n.d.):

- Understanding and conveying information;
- Understanding of facts, ideas and opinions and their presentation;
- Analysing, evaluating and selecting that which is relevant for a given purpose;
- Describing and reflecting on experience, real and imagined;
- Recognising explicit meanings and attitudes and some of the simpler implicit meanings and attitudes, and;

[43] That is, less than 1% of students who participated in the PISA assessment took the Junior Certificate Examination in 1998. The remainder took the examination in 1999 or 2000, or were expecting to take it in 2001.

- Expressing responses to a variety of literary genres.[44]

Many of these areas are also integral to the PISA framework. Each of the skills relates to one or more of the three aspects of PISA reading literacy, namely, retrieval, interpretation and reflection/evaluation. At Higher level, students are expected to demonstrate greater proficiency in these processes, as well as deeper insights and understanding of a wider variety of texts, concepts, and issues. Thus in theory, students at all levels are taught the same broad processes or skills as outlined above; it is the *depth* and *type* of coverage which these processes or skills receive that appears to differentiate between levels, as well as the length, density, and complexity of the texts studied.

The content and structure of Junior Certificate Examination papers provide further insight into the types of tasks that students who have progressed through the Junior Cycle programme are expected to be able to do. The 1999 examination papers are described here. The tasks encountered by students at each level are summarised in Appendix 6, Table A6.1.

Ordinary and Foundation level papers are highly similar in structure. Unlike students at Higher level, Ordinary and Foundation level students are assessed on their performance on a single paper (single assessment session). The Ordinary level paper, however, contains more complex stimulus texts, and contains more questions which require inference and use of outside knowledge. Both the Ordinary and Higher level papers require students to refer to their coursework more than the Foundation level paper does. The Higher level examination consists of two two-and-a-half hour papers, while the Ordinary and Foundation level examinations consist of one two-and-a-half hour paper. Students' responses at Higher level are expected to be greater in length and complexity than those at Foundation or Ordinary levels, and to include aspects of literary criticism and aesthetic appreciation. A broad range of text types and tasks is assessed at all three levels, with a good balance of functional, factual, and literary texts. The balance between course-based texts and unseen texts is achieved by virtue of the fact that students are only required to refer to coursework in half of the sections they attempt.

There is less emphasis on non-continuous texts (documents) in the Junior Cycle syllabus than in the PISA framework. One can assume that students are exposed to non-continuous texts such as charts and graphs in other subject areas such as Geography and History. Apart from this, it is difficult to draw any direct or quantitative comparisons between the PISA framework and the Junior Certificate syllabus or between the PISA assessment and the Junior Certificate English Examination. The PISA assessment focuses on *reading* literacy and contains fewer literary texts than the Junior Certificate Examination, has a greater number of functional (documents) texts, and uses multiple-choice and short open-response formats, whereas the Junior Certificate Examination does not. The Junior Certificate Examination, by contrast, requires students to respond with lengthy compositions or commentaries, many of which are literary or expository. There is, however, some degree of correspondence between the Junior Certificate Examination and the PISA assessment in the sense that there are analogous distinctions made between various processes involved in reading (e.g., retrieving information, interpreting text, and reflecting on text) in both the Junior Cycle syllabus and teacher guidelines.

[44] Other abilities emphasised by the Junior Certificate syllabus include showing a sense of audience and writing in paragraph form with the appropriate spelling and punctuation.

Table 6.1. Junior Certificate English (1989 Syllabus): Strands, Targets, and Activities, by Year Level

Strand	*First Year*	*Second Year*	*Third Year*
Language	Develop an understanding of basic forms and structures of sentences and paragraphs; develop basic punctuation conventions; have lexical awareness, have a sense of audience.	Develop an understanding of: forms and structures of longer compositions; basic punctuation conventions; more complex spellings; more challenging sense of audience and purpose; and lexical awareness.	Develop an understanding of vocabulary to discuss language use (e.g., connotation, cliché); manipulative language techniques; appropriateness of style and register; strategies for spelling and punctuation.
Literature	Understand and use the following: hero/villain, conflict, tension, climax, point of view, characters and relationships, scenes and story-shape, sound, texture and rhythm, style and word selection, and sensationalism/realism.	Understand and use the following: contrast, narrative voice, character development and motivation, beginning/end; mood, atmosphere, tone; style, word-pattern, and verbal choice. Literary forms of short story, novel and play.	Understand and use the following: plot, comedy, tragedy, satire, pathos, melodrama, theatre, lyrical, narrative, tone, irony and symbolism.
Oral/Aural	Encouragement to: tell an anecdote; have small group discussion; describe and report on events, places, people; interview and question; comment on television or radio programmes, and simple dramatic improvisation.	Encouragement to: record and dramatise narrative; engage in debates; give short speeches; ask questions in public lecture settings; discuss and evaluate media experiences, and present short dramatic scenes from texts.	Encouragement to: talk and listen in a wide range of contexts, both formal and informal, building on the activities of the previous two years.
Reading	Encouragement to: read own and others' written work for revision and editing purposes; read silently for a variety of purposes; use reference resources; read newspapers, and watch television programmes; attend to word choice, images and presentation; read a variety of literary genres with an awareness of sound, texture and rhythm.	Encouragement to: read silently for a more sustained period; engage in independent reading; read newspapers, journals, attending to viewpoint, assumptions, accuracy and style; contrast and evaluate different print media; comment on use of illustrations; view TV programmes and comment on implicit values; and read widely.	Encouragement to: identify types of order (e.g., chronological, spatial, importance); identify a writer's purpose; draw conclusions, predict outcomes, and suggest implications; be aware of narrative stance of the writer; distinguish between fact and opinion, and identify material which contains the language of stereotyping.
Writing	Procedures emphasised: prewriting, writing, rewriting and editing. Encouragement to: give information in note form; compose captions and titles; fill in application forms; report on an event; write personal and business letters; keep a diary; write simple dialogue and verse; and review literature, films and television programmes.	Encouragement to: develop the craft of writing; write reports; write formal letters; devise application forms, advertisements and brochures; write descriptive and argumentative essays; compose alternative scenes in literary texts; write in various literary forms; and evaluate a range of literary and media experiences.	Encouragement to: write more extended compositions in a wide range of contexts; and show a clear awareness of audience, purpose and register.

Note. No explicit distinction between Higher, Ordinary and Foundation level syllabi is made in syllabus and teacher guideline documents; teachers must infer, with due regard to students' backgrounds and abilities, and from past and sample examination papers, what these differences are.
Source: Adapted from NCCA (n.d., pp. 3-15)

A recent report from the Chief Examiner of Junior Certificate English (Department of Education, 1994), based on an analysis of a random sample of 5% of students' examination scripts from all examination levels, provides valuable insights into the strengths and weaknesses of Junior Certificate candidates. Comments pertaining in particular to comprehension and writing are summarised briefly here, as it is these areas which are most relevant to the PISA assessment. Commenting on the responses of students, the Chief Examiner made the following general observations:

- Higher level students appeared to use good time management skills in responding to the papers, with most candidates completing all the required sections.
- The majority of Ordinary level students displayed interest in, engagement with, and sincerity in their responses. The Examiner noted that general reading skills appeared to have improved from previous years.
- Foundation level students showed an obvious engagement with and enjoyment of the material on the paper, and the vast majority made a sustained attempt to respond, thereby satisfying the requirements of the examination in most cases.
- Students at all levels often failed to pay attention to the question rubric (e.g., a long answer was given where a short one was required, leading to repetition within and across questions).
- Performance was poorer overall in drama, personal, and especially functional writing.
- Students were not good at identifying evidence to support conclusions they drew.
- Students tended, at times, to give a correct answer but failed to elaborate on or justify their choice of response.
- Students were, by and large, good at creative and narrative writing but overly dependent on these types of writing in answering questions.
- Whilst students were able to adequately compare and contrast aspects of texts, when asked to critically evaluate, they tended to summarise the content of the piece.

The Chief Examiner concluded that formal writing (e.g. composing a letter for a job application) was in need of more attention, and that students' ability to discuss and analyse text was limited, with a tendency to narrativise and summarise when asked to discuss, evaluate, criticise and so on.

JUNIOR CYCLE MATHEMATICS

Current Issues in Mathematics Education in Ireland

Research and commentary from Oldham's (1980a, b, 1992, 2001, personal communications) work, syllabus documents for the Junior Cycle (Department of Education and Science, 1999a), and Chief Examiners' Reports (Department of Education and Science, 1996a, 1998a, 1999b) give an insight into the approach taken in the teaching of mathematics and the elements of mathematics which are emphasised. These, along with a recent review of the Junior Cycle (NCCA, 1999), inform the commentary in this section.

Oldham has traced the development of the syllabus currently in use in third year of the Junior Cycle[45] to the 1960s, which coincided with a period of great change in mathematics courses world-wide. 'Modern' mathematics was characterised by its emphasis on *structure* and *rigour*. The traditional areas of mathematics were reinterpreted in terms of complex algebraic, topological, and order structures, and these were reflected in the syllabus by the emphasis on structure laws (such as commutative, associative, and distributive properties). New areas introduced included sets and relations, statistics, and number bases. The new courses also addressed a perceived problem in their predecessors: students were finding difficulty with the (comparatively) traditional presentation of formal geometry, so Papy's system, based on couples and transformations of the plane, was introduced alongside the existing version based on congruency. For the examinations, papers clearly delineated by topic – arithmetic, algebra and geometry – were replaced by ones in which a more integrated approach was taken, consonant with the 'modern' vision of mathematics. In 1973, after seven years, revised versions were introduced to deal with some aspects that were causing difficulty, notably the format of the examination papers and the hybrid manner in which geometry was being taught. Also around that time, the size of the cohort taking the (then) Intermediate Certificate grew considerably. Thus, courses originally designed with the needs of a comparatively able group were now being offered to a wider ability range. The rather abstract and formal nature of the 'modern' work was not suitable for weaker students, and further revisions were needed. In the early 1980s, therefore, it was decided to introduce a third course, geared to their needs (Foundation mathematics). Amendments were also introduced to the former Higher and Lower courses. The package of three courses, then called Syllabus A, B, and C, was introduced in 1987, for first examination in 1990.

Mathematics Syllabus and Assessment

In 1989, the Intermediate Certificate Examination was replaced by the Junior Certificate Examination. As Intermediate Certificate Mathematics courses had been recently revised, they were adopted as Junior Certificate courses without further consideration (except that Syllabus A, B, and C were renamed Higher, Ordinary, and Foundation courses). It should be noted that, as a result, there was no opportunity to review the courses thoroughly or to give due consideration to an appropriate philosophy and style for Junior Cycle mathematics in the 1990s and the new millennium. The content of the 1989 Junior Certificate syllabus is described in Table 6.2.

Note that the table does not give an indication of the detail in which topics are covered at each level. It can be seen, however, that whilst there is not a huge difference between the Higher and Ordinary level courses in terms of topics, the Foundation level course focuses chiefly on 'social mathematics', i.e., the types of mathematical concepts and operations that one is likely to encounter in everyday life, such as those involving money, percentages, area, and volume. The main difference between the Higher and Ordinary level papers is in terms of the level of abstraction of topics, especially in algebra and geometry.

[45] The new Junior Certificate mathematics syllabus is being implemented in first year for the first time in the 2000-2001 school year and will be examined for the first time in 2003. The role of calculators, aspects of the geometry syllabus, and design of examination papers have undergone significant revisions. In addition, the length of the Higher level course has been shortened. One purpose of the revision of the mathematics syllabus was to establish alignment and continuity with the recently revised mathematics curriculum in primary schools.

Table 6.2. Outline of Topics Covered at Higher, Ordinary, and Foundation Level Mathematics at Junior Cycle – 1989 Syllabus Grouped Under Revised (2000) Syllabus Topic Headings

Topic	*Sub-topic*	*H*	*O*	*F*
Sets	Elements, membership, universe, subset, null set, equality of sets, couples	✓	✓	✓
	Venn diagrams	✓	✓	✓
	Set operations: intersection, union, complement	✓	✓	✓
	Set operations: difference	✓	✓	
	Set operations: symmetric difference	✓		
	Set operations extended to three sets	✓	✓	
	Commutative property	✓	✓	✓
	Associative property	✓		
	Cartesian product	✓		
Number Systems	The set N: commutative property, place value, sets of multiples, lowest common multiple	✓	✓	✓
	The set N: sets of divisors, pairs of factors, prime numbers, cardinal number, rules for indices	✓	✓	
	The set N: addition, subtraction, multiplication and division, approximation	✓	✓	✓
	The set Z: positional order on the number line, addition	✓	✓	✓
	The set Z: order, addition, subtraction, multiplication and division	✓	✓	
	The set Q^+: decimals, fractions, percentages; addition, subtraction, multiplication and division	✓	✓	✓
	The set Q: decimals, fractions, percentages; addition, subtraction, multiplication and division	✓	✓	
	The set Q: Rounding to a maximum of three decimal places, approximation	✓	✓	✓
	The set Q: ratio and proportion	✓	✓	
	Surds: arithmetic operations applied to $a + \sqrt{b}$	✓		
	The set R: every point on the number line represents a real number	✓	✓	
	Use of square roots, square [and reciprocal – higher and ordinary] tables	✓	✓	✓
	Scientific notation	✓	✓	
	Logarithms	✓		
Applied Arithmetic and Measure	Bills; percentage profit and discount; rates and tax; VAT; compound interest, etc.	✓	✓	✓
	Basic units of length, mass, time (including 24 hour clock and transport timetables)	✓	✓	✓
	Multiples and submultiples	✓	✓	
	Speed	✓	✓	✓
	Area of square, triangle and rectangle	✓	✓	✓
	Volume of rectangular solids	✓	✓	✓
	Meaning of radius, diameter and chord as line segments	✓	✓	✓
	Circumference of a circle	✓	✓	✓
	Area of a circle	✓	✓	
	Use of formulae provided to calculate volume of cylinder [and sphere – ordinary only]		✓	✓
	Surface areas and volume of cylinder, cone and sphere	✓		
	Applications of Pythagoras' Theorem	✓		
	Calculating distance on a map, drawing to scale			✓

Note. H = Higher level; O = Ordinary level, and F = Foundation level.
Source: Department of Education and Science (1999a, 2000b); Oldham (personal communication)

Table 6.2. Continued

Topic	*Sub-topic*	*H*	*O*	*F*
Algebra	Evaluation of expressions	✓	✓	✓
	Meaning of variable, constant, term, expression, and coefficient	✓	✓	
	Rearrangement of formulae	✓	✓	
	Addition, subtraction, multiplication, and division	✓	✓	
	Distributive property, factors	✓	✓	
	First degree equations in one variable	✓	✓	✓
	First degree equations in two variables	✓	✓	
	Quadratic equations	✓	✓	
Statistics	Bar charts, pie charts, trend graphs: drawing and interpreting	✓	✓	✓
	Frequency tables	✓	✓	✓
	Histograms: drawing and interpreting	✓		
	Measures of central tendency	✓	✓	✓
	Cumulative frequency	✓		
	Interquartile range	✓		
Geometry	Use of geometric instruments to draw figures from given data	✓	✓	✓
	Verification, without proof, of properties of triangles, rectangles and circles, e.g., the three angles in a triangle sum to 180°; Pythagoras' Theorem; the angle in a semicircle is a right angle			✓
	Axial symmetry and translation	✓	✓	✓
	Central symmetry	✓	✓	
	Rotation and parallel projection	✓		
	Congruency	✓	✓	
	Theorems on the properties of triangles and parallelograms, e.g., the angles at the base of an isosceles triangle are equal	✓	✓	
	Proportionality theorems, e.g., a line drawn parallel to one side of a triangle divides the other two sides in the same ratio	✓		
	Pythagoras' theorem	✓		
	Theorem: the angle in a semicircle is a right angle	✓	✓	
	Theorems on the properties of circles, e.g., a line is tangent to a circle at a point t on the circle if it is perpendicular to the diameter through it; if [ab] and [cd] are two chords of a circle intersecting in k, then $\|ak\|*\|kb\| = \|ck\|*\|kd\|$	✓		
	Constructions, e.g., bisecting an angle (requirements are different for each level)	✓	✓	✓
	Co-ordinating the plane	✓	✓	✓
	Co-ordinates of images and points under translation, axial symmetry, central symmetry and parallel projection	✓		
	Distance and midpoint; slope of a line	✓	✓	
	Parallel and perpendicular lines	✓		
	Equation of a line in two forms: $y = mx + c$ and $y - y_1 = m(x - x_1)$	✓	✓	
	Intersection of lines; equation of a line under a translation; area of a triangle	✓		
Trigonom-etry	Cosine, sine and tangent of angles; reading trigonometric tables	✓	✓	
	Solving right-angled triangle problems	✓	✓	
	Sine rule and applications	✓		
Relations, Functions and Graphs	Relations, use of arrow diagrams	✓	✓	✓
	Domain [codomain – higher only], range; function as a special relation	✓	✓	
	Composition of relations, inverse of a function	✓		
	Plotting points having integral co-ordinates. Joining points to form a line	✓	✓	✓
	Drawing graphs of linear functions	✓	✓	✓
	Drawing graphs of quadratic functions	✓	✓	
	Minimum and maximum value of quadratic functions found graphically	✓		
	Graphing solution sets: linear inequalities in one variable	✓	✓	
	Graphical treatment of solution of first degree equations in two variables	✓	✓	
	Solution of quadratic inequality found from the graph of a quadratic function	✓		

Note. H = Higher level; O = Ordinary level, and F = Foundation level.
Source: Department of Education and Science (1999a, 2000b); Oldham (personal communication)

Analyses of the Irish mathematics syllabus carried out as part of the Third International Mathematics and Science Study (TIMSS) (Schmidt et al., 1997) identified some differences between it and syllabi in other countries which may be mentioned as they may bear on the interpretation of results in PISA. Note that the analyses of syllabus documents were carried out by mathematics curriculum experts and that the conclusions drawn may not perfectly reflect what happens in mathematics classrooms. First, Irish curriculum guides had a relatively low amount of objectives, pedagogical and assessment suggestions, compared with other countries. Second, many topics were introduced at an earlier age than the median age of students in other countries. These included number (exponents and orders of magnitude), measurement (estimation and error), 3-D geometry, patterns, relations and functions, and data representation and analysis. The time and method of introduction of a mathematics topic, especially more complex ones, may merit further examination, since, for example, and as pointed out in Chapter 2, Irish students have a comparatively poor track record in geometry and measurement in international assessments, despite the fact that these topics are introduced relatively early. Third, the duration for which many topics were taught was found to be greater than the TIMSS median for several topics, and these again included 3-D geometry and measurement, as well as aspects of number (estimating computations, exponents, and order of magnitude) and data representation. This, coupled with the second point above, suggests that these topics are being introduced too early or at any rate that they are not well understood. Fourth, in comparing the numbers of topics covered at each grade level, Ireland covered many more topics at the higher grade levels than the higher-achieving countries such as Korea, Hong Kong, Japan, and the Czech Republic. These observations lead to the inference that higher-achieving countries tend to concentrate on fewer topics, according each more time at a given grade level, and drop more topics at the higher grade levels.

Comparing recent Junior Certificate Examination papers with the PISA assessment, one can see notable differences in the approaches to mathematics, especially in terms of the manner in which problems are contextualised. In the Junior Certificate Examination papers, questions are presented in a purely mathematical and abstract context. There is little or no redundant information. In the PISA assessment, on the other hand, questions are often embedded in rich real-life contexts, accompanied by texts and diagrams (see the example items in Appendix 1), and students are often required to discriminate between necessary and redundant information, as well as actually formulate the problem, in order to solve it. The PISA framework draws from the Realistic Mathematics Education (RME) approach, initiated in the Netherlands about 30 years ago (van den Heuvel-Panhuizen, 1998). RME can be described in terms of the following five characteristics (Treffers, 1987; cited in van den Heuvel-Panhuizen, 1998):

- The use of contexts.
- The use of models.
- The use of students' own productions and constructions.
- The interactive character of the teaching process.
- The intertwining of various learning strands.

A further source of information on the mathematics syllabus in Ireland comes from Chief Examiners' Reports (Department of Education and Science, 1996a, 1998a, 1999b) of Junior Certificate Mathematics Examinations. The reports indicate that Higher level students showed strengths in statistics, numerical calculations involving decimals, drawing graphs, factors, simple and compound interest, and basic co-ordinate geometry. Areas in which they were found to be weak were identified in two or all three of the reports and included calculation of area and volume in terms of π; simplifying algebraic expressions and solving quadratic equations; performing arithmetic calculations involving fractions, decimals, minus signs and division; using binary operations; inverse functions; using logarithms and indices; managing square roots; and application of theorems. The 1998 report also highlighted the fact that a proportion of students taking the Higher level course exhibited general weaknesses in mathematical skills. Such students were unable to do basic calculations and did not seem to have a 'feel' for what they were doing. For example, in calculating the interest on a sum of money, some candidates gave an answer that was larger than the original figure and did not appear to be thinking about what the question or the answer was supposed to represent, possibly working at a mechanical level. There was also a proportion of students whose work suggested that they had not studied all aspects of the course, such as geometry, logarithms, or trigonometry. This suggests that syllabus coverage is not entirely even.

At Ordinary level, a number of weaknesses were noted in the reports. The basic arithmetic skills of some students were considered poor; calculations, especially division, involving decimals and minus signs, were weak; the overall standard of algebra was poor, as were geometric construction and transformational geometry skills; in the area of functions, both concept and notation were weak; scientific notation was also weak; and there was evidence of a lack of transfer of knowledge across questions.

At Foundation level, the following points were noted. Many students failed to use geometrical instruments where appropriate, and lack of familiarity with geometry was evident; students were not familiar with interpreting problems in visuo-spatial format; graphing co-ordinates was weak, as was drawing Venn diagrams; basic computational errors were common; and the performance of many students was restricted by poor reading and comprehension skills. Words such as 'divisible', 'verify' and 'approximate' seemed unfamiliar to many students at this level, and answers were often given with no work shown.

In summary, many aspects of geometry, algebra and trigonometry have been identified as areas of weakness across all syllabus levels. Many students apparently lacked basic mathematical skills. There was also some evidence that many students approached mathematics in a mechanical manner and did not use higher-order reasoning in working out answers.

Although PISA focuses on two main strands of mathematics, change and growth and space and shape, its mathematics item pool contains some topics in the Junior Certificate syllabus (see Chapter 1, Table 1.2). The strands of geometry, measurement, statistics, algebra, and functions account for all of the items in the PISA mathematics assessment which, as noted above, are topics which are associated with both strengths and weaknesses in terms of Junior Certificate Examination performance.

JUNIOR CYCLE SCIENCE

Current Issues in Science Education in Ireland

A range of problems relating to science education in Irish schools has been identified. These include the relative neglect of science in primary schools; the fact that science is not part of the core curriculum in second-level schools, with the result that some students (especially those in all girls schools) complete their second-level studies without having studied a science subject; the heavy weighting towards Biology when science is taught; the shortage of teachers with Physics and Chemistry backgrounds in second-level schools; the constraints that the State examination system places on the teaching of science; and the decline in recent years in the percentage of students taking a science subject in the Leaving Certificate Examination (Walsh, 1999).

In light of this situation, it is hardly surprising that much effort is currently being invested in updating and modernising science and technology education (involving syllabus, assessment, and resources). In a recent discussion paper on science and technology education in the Senior Cycle of second-level schools, the NCCA (2000) pointed out that

> A broad and balanced science and technology education should enable all our students to become more informed and interested citizens, literate in science and technology. They should be capable of debating and critically questioning issues and views that form such a central part of their own lives and that of society at local, national and international levels. They should appreciate the value of science and technology products, which permeate our lives, and their contribution to our culture and vibrant economy. For some of our students, the study of science and technology represents the start of a process that will lead to their becoming the scientists and technologists of the future. (p. 3)

This statement touches on several points which science educators such as Keeves (1992) and Loucks-Horsley and Bybee (1999) have also made, and are pertinent to successful science education in almost any country:

- The reference to 'all' students implies that science education should be made available (or possibly even taught) to every student, regardless of ability.
- The reference to 'literate in science' is consistent with the view of science espoused in the PISA assessment framework and also implies that science is comparable in importance to reading and mathematics.
- References to 'debating' and 'critically questioning' imply that the types of skills all students should be taught relate to an understanding of the scientific method of inquiry and the manner in which scientific discoveries and products are communicated through the media. These skills feature strongly in the PISA assessment of scientific literacy.
- The last sentence in the NCCA's report appears to make a distinction emphasised by Loucks-Horsley and Bybee between the science knowledge required by scientists and the science knowledge required by non-scientists, which further implies that students will differ in their science education needs, depending on their interests and abilities.

The NCCA (2000) lists and discusses several problems in current science education, many of which are relevant to the performance of students on the PISA assessment and to problems identified by Walsh, above.

- At present, one in nine students (almost 12%) does not receive any science education at Junior Cycle level.
- Although the number of students taking science at Junior Certificate level has remained stable over the past decade or so, there is a decline in the percentage of students taking science at Leaving Certificate level.
- There is a perception that the physical sciences are only for the highest achievers, that they lack relevance to everyday life, that the content is too difficult, and that a low status is accorded to practical skills.
- In terms of provision, the NCCA notes that science is almost universal at Junior Certificate level, being available in 98.5% of second-level schools. The schools which do not provide science are vocational. At Leaving Certificate level, Biology is available in 96% of schools, Physics in 80%, and Chemistry in 70%; however, Agricultural Science is only available in 22% of schools and Physics/Chemistry (combined) in 15%. The NCCA highlights the lack of provision of Physics and Chemistry in vocational schools as a particular cause for concern. It also suggests that the lack of teachers specialising in Physics and Chemistry may result in an over-emphasis on the teaching of Biology at Junior Cycle level.

- While almost half of students take Biology in the Leaving Certificate Examination, only 15% take Physics and 11% Chemistry; Physics/Chemistry (combined) is studied by only 2%.
- Of key importance in the successful provision and teaching of science subjects is the adequacy of school resources. In 1998, the Department of Education and Science carried out an audit in all second-level schools to establish existing levels of science facilities. The modernisation of science labs is being undertaken as part of the £15m. (19m. Euro) physical sciences initiative, launched in March 1999. The provision of lab assistants is another issue which, the NCCA argues, merits further attention.
- Another issue of key importance is an early and structured introduction to science. The NCCA describes the inclusion of a science programme as 'one of the most significant changes in the revised Primary [School] Curriculum [1999]' (p. 33).

The NCCA pledges to implement an ongoing review designed to assess the success of the new syllabi and to monitor other issues such as gender differences in performance and developments in other countries. It is planned to use the results from the PISA assessment as an important benchmark in this review.

Science Syllabus and Assessment

The syllabus document for the Junior Cycle (Department of Education, n.d.) provides an insight into the approach taken in the teaching of science and the elements of science which are emphasised. This document, along with recent Chief Examiners' Reports (Department of Education, 1996c), and input from the NCCA (Lynch, personal communication) inform the commentary in this section.

The aims of education in science at Junior Cycle level as set out in the revised syllabus (1989) and current in 2000 (the year of the PISA assessment) are to provide students with:

- A body of scientific knowledge essential to their age;
- An understanding of matter, energy, plants and animals, the human body, Earth and the universe;
- An awareness of the potential use, misuse and limitations of science;
- Ability to observe, evaluate, form opinions and make judgements;
- Development of practical, cognitive, affective, and communication science skills related to science;
- Ability to apply scientific knowledge and skills.[46]

Many of these aims are congruent with the PISA framework. Each relates to one or more of the processes essential for scientific literacy as defined in PISA science (recognising scientifically investigable questions; identifying evidence needed in a scientific investigation; drawing or evaluating conclusions; communicating valid conclusions; and demonstrating understanding of scientific concepts). Other links are evident between the concepts emphasised in PISA and those in the Junior Certificate syllabus. PISA focuses on three broad categories (science in life and health, science in earth and environment, and science in technology) which are represented, to varying degrees, in the topic areas listed in Table 6.3. The topic areas in the Junior Cycle Science syllabus are divided into one core and six optional components (extensions), of which science teachers usually cover four. The core component contains basic scientific concepts and processes from Biology, Chemistry, and

[46] Other aims emphasised by the Junior Certificate science syllabus include providing students with an appreciation of and respect for life and environment, an awareness of technological, industrial, social, historical and economic aspects of science and their applications, and ensuring the development of procedural, creative and intuitive skills.

Physics; these and additional concepts and processes are studied in more detail in each of the extensions.[47] However, the inclusion of the study of the human body as separate from the living environment results in a slightly higher emphasis on biological concepts and processes. The range of choice afforded to students in the Junior Certificate science examination has compounded the under-emphasis on Chemistry and Physics. The principal difference between Higher and Ordinary levels is the level of detail and complexity with which a topic is studied. For example, Ordinary level students study the function of the skeleton, while Higher level students also examine the structures and functions of joints, muscles, ligaments, and tendons.

All extensions, and especially the applied science extension, offer students an opportunity to examine scientific processes in-the-world. There is a relatively high emphasis, however, on the learning of concepts and definitions, coupled with less attention to the ethical and political aspects of science and current social, biological and environmental issues. There also appears to be less emphasis on the scientific method of enquiry and the validity and communication of results. Earth science concepts and processes are scattered throughout the syllabus, and are most strongly represented in the optional earth science component of applied science. These points are pertinent to PISA for three reasons. First, some PISA items require students to make judgements about the validity of conclusions, and the testability of assumptions; others require them to communicate scientific principles. It can be argued that the Junior Cycle syllabus does not emphasise these elements. Second, almost one-quarter of the PISA items are related to earth/space science topics, and students may not be familiar with some of the underlying concepts and processes of such items. Third, many of the contexts embedded in the PISA assessment, such as cloning, the greenhouse effect, and science in medicine, are not included on the current Irish science syllabus at Junior Cycle.

Recent Chief Examiners' reports of Junior Certificate science (Department of Education, 1996c) provide a number of insights regarding students' strengths and weaknesses. In discussing the outcomes on the Higher level paper, the Examiner noted that students performed to a satisfactory level on the core part of science, and best on core Biology items (obtaining an average score of 68% on Physics, 70% on Chemistry, and 80% on Biology). The Examiner also noted marked differences in question choice in both Physics and Chemistry extensions (which are broadly similar from year to year). In Physics, the question on heat, temperature, and pressure was much more popular than the question on light and sound. In Chemistry, the question on compounds, salts, and bases was much more popular than the question on water. In the Applied Science section, where students must answer two questions out of six, there were also differences in response rates for the questions. Food science, materials science, and earth science were the three more popular options, while horticulture, electronics, and energy conversions were less popular. Students' performance was better on earth science, energy conversions, materials science, and food science items, than on electronics and horticulture items. In a closer examination of the scripts, the Examiner noted some confusion with scientific vocabulary (e.g., 'momentum' and 'moment'; 'phototropism' and 'photosynthesis'), and that students had difficulty with more complex scientific processes and formulae (such as the formula for respiration).

[47] Table 6.3 does not include a description of the local studies extension as it does not comprise specific topic areas; rather, it is open in content and is based on the scientific study – laboratory work and fieldwork – of some aspect of the locality.

Table 6.3. Broad Topic Content of the Core and Extensions of the 1989 Junior Cycle Science Syllabus

Core	*Physics*	*Chemistry*	*Biology*	*Applied Science (Options)*	*% Taking Option**
Human body (e.g. systems of the body)	Forces and motion (e.g. mass, density, velocity, acceleration, friction, pressure)	Matter, atoms, elements (e.g. subatomic particles, molecules, the periodic table, oxidation and reduction, halogens, valency, endo/ exothermic)	Animal Biology (e.g. cell structure, tissues, organs, nutrition, enzymes, respiration, circulation, excretion, skeleton, basic genetics)	Earth science (e.g. sun, moon and planets, atmospheric and water pressure, properties of gases)	Higher 45.1% Ordinary 74.2%
Non-living environment (e.g. atoms, molecules, elements, solutions, acids/bases, metals)	Heat (e.g. heat and temperature, thermometers, effects of heat, sublimation, kinetic models, heat transfer)	Acids and bases (e.g. pH scale and indicators, specific reactions of acids, neutralisation, acid rain, calcium and magnesium ions and their effects)	Plant Biology (e.g. plant cell structure, chemical reactions underlying photosynthesis, respiration, transpiration, geotropism, plant reproduction)	Horticulture (e.g. soils and composts, propagation, factors necessary for optimal plant growth, crop protection and pest control, grafting)	Higher 7.8% Ordinary 32.9%
Living environment (e.g. animal and plant classification, plant structure, photo-synthesis, food chains, habitat, pollution, micro-organisms)	Electricity and magnetism (e.g. electric current and charge, circuits, AC/DC, Ohm's law)	Metals and electrochemistry (e.g. conductivity, cell batteries, applications of electricity in industry, corrosion, activity series, electrolysis)	Ecology (e.g. fieldwork in local habitat, soil study including mineral composition and micro-organisms, food webs)	Materials science (e.g. identification and classification of materials, uses and properties of materials, alloys, textiles, metals, timber)	Higher 40.5% Ordinary 65.0%
Energy (e.g. energy needs and supplies, nuclear energy, heat, insulation, expansion/contraction, magnetism, electricity)	Light and sound (e.g. light and colour, properties of waves, electromagnetic radiation, sound wave/vibration)			Food (e.g. food types, processing, preservation, food additives and supply)	Higher 72.9% Ordinary 65.0%
				Electronics (e.g. simple circuits, LEDs, switches, variable resistors, LDR, transistor and transducer)	Higher 11.1% Ordinary 29.6%
				Energy conversions (e.g. radiation, stored, and kinetic energy, energy changes in various systems, electromagnetism, dynamo, DC motors)	Higher 19.8% Ordinary 42.4%

Note. No distinction is made here between the content of the Higher and Ordinary syllabus levels; see Department of Education (n. d.) for more detail.
*Estimates based on a random sample of responses of 5% of students taking Junior Certificate science in 2000.

In Ordinary level science, the Examiner noted that the popularity of questions was broadly similar, (although the question choices for Physics and Chemistry were more balanced), and that the core items were in general well answered. The Examiner also noted that many students appeared to have problems with basic definitions and concepts.

Arising from concerns that Chemistry and Physics (especially the former) are under-represented in the core and options of the Junior Certificate science syllabus and assessment, and in light of the low level of uptake in some of the extensions, the NCCA is undertaking a review of this syllabus. A revised science syllabus, which is expected to be ready early in 2002, will ensure a greater balance between Biology, Chemistry, and Physics. Students will be required to give equal attention to all three components in their learning of science. Increased emphasis will be placed on an active, 'hands-on' approach to the learning of science; to its investigative nature; and to the development of problem solving skills. Changes in assessment will reflect the changed approach adopted in the revised syllabus.

STUDENT PERFORMANCE ON THE 1999 JUNIOR CERTIFICATE EXAMINATION

There are several important differences between the type of assessments employed in the Irish education system and in the PISA assessment. Further, while the Junior Certificate Examination does not explicitly assess the skills and processes of reading, mathematical and scientific literacy assessed in PISA, the performance of students on the 1999 Junior Certificate Examination[48] is still worth considering, as it provides a general idea of internal national standards and gender differences. As students sitting the Junior Certificate Examination have a modal age of 15, this is the closest we can come to a national comparison point with the PISA assessment.

Junior Certificate English Examination

In 1999, a total of 62,659 students (30,886 females and 31,779 males) sat the Junior Certificate Examination (Department of Education and Science, 2000). Of these, almost all (62,165; 99.2%) sat Junior Certificate English. Just over three-fifths (62.9%) took Higher level English and almost one-third (32.9%) Ordinary level; the remainder (4.3%) took English at Foundation level. About one in three students at both Higher and Ordinary levels and about two in five at Foundation level obtained a grade A or B. E and F grades were about the same at Higher (2.2%) and Ordinary (2.3%) levels, while almost one student in ten was awarded a grade E or lower at Foundation level.

As the results of the IEA Reading Literacy Survey (IEA/RLS) would lead one to expect (Chapter 2), there are striking gender differences. These are reflected, in the first place, in the fact that, in 1999, more than twice as many boys as girls took Foundation level English, and more girls than boys took English at Higher level (Table 6.4).

Gender differences in achievement are also in evidence. At Higher level, the percentage of females (38.7%) who obtained a grade A or B was more than one-and-a-half times the percentage of males (23.3%), while the percentage of males (3.4%) who obtained a grade E or F is three times the percentage of females (1.1%). The same general pattern can be observed at Ordinary level, while at Foundation level the difference is also in evidence but not as marked. When one examines the percentages of males and females obtaining less than a grade D on any level of the examination, the ratio is about 3:1. This pattern closely resembles findings from IEA/RLS in which three times as many males as females at age 14 scored two or more standard deviations below the mean.

[48] The 1999 results are, at the time of writing of the report, the most recent ones available.

Table 6.4. Percentages of Male and Female Candidates Achieving Various Grades in the 1999 Junior Certificate English Examination, by Examination Level

Group	*N*	*Grade A 85-100%*	*Grade B 70-84%*	*Grade C 55-69%*	*Grade D 40-54%*	*Grade E 25-39%*	*Grade F 10-24%*	*No Grade 0-9%*
Higher								
Males	17,458	4.0	19.3	42.2	31.1	3.1	0.3	0.0
Females	21,621	8.5	30.2	42.2	18.0	1.1	0.0	0.0
All	39,079	6.5	25.3	42.2	23.8	2.0	0.2	0.0
Ordinary								
Males	12,224	4.4	21.8	44.0	26.7	2.6	0.4	0.0
Females	8,218	9.8	31.2	42.7	15.2	1.0	0.1	0.0
All	20,442	6.6	25.6	43.5	22.1	2.0	0.3	0.0
Foundation								
Males	1,817	6.6	27.4	34.6	20.2	6.9	3.4	0.9
Females	827	13.1	33.5	30.5	18.0	2.8	2.2	0.0
All	2,644	8.6	29.3	33.3	19.5	5.6	3.0	0.6

Note. Row percentages may not sum to 100 due to rounding.
Source: Department of Education and Science (2000)

Inset 6.1. Junior Certificate Overall Performance Scale (OPS) Scores

To make direct comparisons between performance on PISA and performance on the Junior Certificate Examination, it is useful to put the performance of all students, regardless of the level at which they took the examination, on the same scale. The following 12-point Overall Performance Scale (OPS), with a three-grade overlap between examination levels, has been used in a number of studies (e.g., Kellaghan & Dwan, 1995; Martin & Hickey, 1993). Although Overall Performance Scales have in previous studies referred to the mean performance of students on all subjects they took in the Junior Certificate Examination, they are used here to denote performance on a single subject (English, Mathematics, or Science).

Because there is no Foundation level Science in the Junior Certificate Examination, a 9-point scale was used ranging from 4 (F, Ordinary level) to 12 (A, Higher level).

Prior to finalising the scales, the properties of alternative 10- and 14-point Overall Performance Scales (and in the case of Mathematics, a 16-point scale) were investigated (Appendix 6, Table A6.2). It was concluded that the 12-point scale for English and Mathematics, and a 9-point scale for Science, worked best.

Higher	**Ordinary**	**Foundation**	***OPS Score***
A			*12*
B			*11*
C			*10*
D	A		*9*
E	B		*8*
F	C		*7*
	D	A	*6*
	E	B	*5*
	F	C	*4*
		D	*3*
		E	*2*
		F	*1*

When the performances of students at all levels on the Junior Certificate English Examination are placed on a single scale yielding Overall Performance Scale scores (OPS scores; Inset 6.1), the same pattern of gender differences, not surprisingly, emerges.

Table 6.5 illustrates the breakdown of male and female students' scores on the 12-point OPS scale and the mean OPS scale scores associated with each group. Overall, females score 0.9 of a point higher than males.

Almost three times the percentage of females (6.0%) as of males (2.2%) scored at the top point on the scale. A score of 11 points was obtained by twice the percentage of females (21.3) as of males (10.7). The percentages of males and females with scores from 7 to 10 are quite close (69.7 for males; 65.6 for females). However, for scores below 7, the pattern evident at the top of the scale is reversed. More than twice the percentage of males (16.8%) as of females (7.0%) have OPS scores from 3 to 6.

Millar and Kelly (1999) have pointed out that this gender-related pattern of achievement can be observed in the majority of Junior Certificate Examination subjects, with the same pattern apparent at Leaving Certificate level. The pattern may partly be a function of the higher incidence of reading literacy problems in boys compared to girls. Millar and Kelly also note that this pattern has not varied much in recent years, although the exact proportions of candidates awarded each grade varies from year to year (see the annual Statistical Reports of the Department of Education and Science for Junior Certificate Examination data for other years).

Table 6.5. Percentages of Male and Female Candidates Achieving Various Scores on the Overall Performance Scale (OPS), With Mean OPS Scores, on the 1999 Junior Certificate English Examination

Group	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*Mean (SD)*
% Males	2.2	10.7	23.4	18.9	10.2	17.2	10.8	2.6	2.2	1.2	0.4	0.2	8.4 (2.01)
% Females	6.0	21.3	29.7	15.3	9.1	11.5	4.4	1.2	0.9	0.5	0.1	0.1	9.3 (1.81)
% Total	4.1	15.9	26.5	17.1	9.7	14.4	7.6	1.9	1.5	0.8	0.2	0.1	8.9 (1.95)

Note. Row percentages may not sum to 100 due to rounding.

Junior Certificate Mathematics Examination

As in the case of Junior Certificate English, almost all examination candidates (61,745; 98.5%) sat Junior Certificate Mathematics in 1999. About one-third (36.0%) took the subject at Higher level and about one half (51.3%) at Ordinary level; the remainder (12.7%) at Foundation level. Compared to English, a lower proportion of students took a Higher level examination. This may partly explain why a slightly higher proportion of candidates in Mathematics than in English obtained a grade A or B at Higher level — over two-fifths compared with one-third. However, despite the fact that the percentage of students taking Mathematics was greater than the percentage taking English at Foundation level, the percentages obtaining a grade A or B were similar in both subjects. The percentage obtaining a grade E or F in Foundation level Mathematics (7.7%) is similar to the percentage in English, while the percentage obtaining an E or F at Higher (5.1%) and Ordinary (9.0%) levels is higher in Mathematics.

Gender differences are less pronounced than in English. The percentages of males and females taking the examination at each level are fairly similar, although a somewhat higher percentage of boys (14.5%) than of girls (10.8%) took the Foundation level paper (Table 6.6). While the percentages of males (44.6%) and of females (43.4%) obtaining grade A or B are similar at Higher level, females demonstrated a slight advantage at Ordinary level (34.4% of males; 37.5% of females). This pattern can also be seen at Foundation level, with 41.3% of males and 45.6% of females achieving an A or B. At the lower end of the achievement spectrum, more males than females obtained a grade E, F or No Grade (5.7% compared to 4.7% at Higher level; 11.0% compared to 7.5% at Ordinary level; and 9.5% compared to 6.0% at Foundation level). When the data for all three levels are combined, one finds that 9.0% of males, compared to 6.3% of females, obtained a grade lower than D, regardless of level.

Table 6.6. Percentages of Male and Female Candidates Achieving Various Grades in the 1999 Junior Certificate Mathematics Examination, by Examination Level

Group	N	Grade A 85-100%	Grade B 70-84%	Grade C 55-69%	Grade D 40-54%	Grade E 25-39%	Grade F 10-24%	No Grade 0-9%
Higher								
Males	10,829	14.5	30.1	30.6	19.1	4.6	1.0	0.1
Females	11,411	12.3	31.1	33.2	18.7	4.0	0.7	0.0
All	22,240	13.4	30.6	32.0	18.9	4.3	0.8	0.0
Ordinary								
Males	15,977	6.6	27.8	30.9	23.7	7.9	2.7	0.4
Females	15,697	8.8	28.7	32.3	22.7	5.9	1.5	0.1
All	31,674	7.7	28.3	31.6	23.2	6.9	2.1	0.3
Foundation								
Males	4,546	10.5	30.8	29.9	19.4	6.6	2.5	0.4
Females	3,285	11.6	34.0	31.0	17.4	4.3	1.6	0.1
All	7,831	11.0	32.1	30.4	18.5	5.6	2.1	0.3

Note. Row percentages may not sum to 100 due to rounding.
Source: Department of Education and Science (2000)

A consideration of performance in terms of the Overall Performance Scale (OPS; see Inset 6.1) also indicates that the achievement of males and females is more balanced in Mathematics than in English, though overall, the performance of females is superior, with a score difference of 0.4. Greater percentages of males than of females obtained high (12) and low (1 to 6) scores, while the percentages obtaining intermediate scores (7 to 11) are greater for females than for males (Table 6.7).

Table 6.7. Percentages of Male and Female Candidates Achieving Various Scores on the Overall Performance Scale (OPS), With Mean OPS Scores, on the 1999 Junior Certificate Mathematics Examination

Group	12	11	10	9	8	7	6	5	4	3	2	1	Mean (SD)
% Males	5.0	10.4	10.6	9.9	15.8	16.1	13.6	8.5	5.7	2.8	1.0	0.4	7.6 (2.42)
% Females	4.6	11.7	12.5	11.5	16.3	16.9	13.0	6.7	4.1	1.9	0.5	0.2	8.0 (2.27)
% Total	4.8	11.0	11.5	10.7	16.0	16.5	13.3	7.6	4.9	2.3	0.7	0.3	7.8 (2.35)

Note. Row percentages may not sum to 100 due to rounding.

Junior Certificate Science Examination

Almost seven-eighths of all Junior Certificate Examination candidates (54,387; 86.8%) sat a Science examination in 1999. A greater percentage of male (91.2%) than of female (82.4%) candidates took the subject. Almost two-thirds of candidates (64.3%) took Science at Higher level and over one-third (35.7%) at Ordinary level. These percentages are similar to those for Junior Certificate English. The percentage of candidates obtaining A or B grades in Higher level Science (43.6%) was almost twice the percentage in Higher level English (22.8%). The percentage obtaining E, F, or No Grade was higher for Ordinary level (10.1%) than for Higher level (7.1%) Science candidates.

Of those students taking science, a higher percentage of females (70.2%) than of males (59.0%) took Higher level science, and the percentage of females (46.6%) who obtained a grade A or B exceeded the percentage of males (40.3%). At Ordinary level also, the percentage of females (26.6%) obtaining these two top grades exceeded the percentage of males (20.5%) (Table 6.8).

Table 6.8. Percentages of Male and Female Candidates Achieving Various Grades in the 1999 Junior Certificate Science Examination, by Examination Level

Group	*N*	*Grade A 85-100%*	*Grade B 70-84%*	*Grade C 55-69%*	*Grade D 40-54%*	*Grade E 25-39%*	*Grade F 10-24%*	*No Grade 0-9%*
Higher								
Males	17,116	13.7	26.6	29.3	22.0	6.8	1.4	0.1
Females	17,836	17.3	29.3	28.2	19.2	5.1	0.9	0.0
All	34,952	15.6	28.0	28.8	20.5	5.9	1.1	0.1
Ordinary								
Males	11,878	2.0	18.5	39.5	29.0	8.0	2.8	0.2
Females	7,557	3.2	23.4	39.2	25.7	7.0	1.4	0.1
All	19,435	2.4	20.4	39.4	27.7	7.6	2.3	0.2

Note. Row percentages may not sum to 100 due to rounding.
Source: Department of Education and Science (2000)

When Science grades are converted to the Overall Performance Scale (OPS; see Inset 6.1), the advantage of female students is again evident: overall, OPS scores of females are 0.6 points higher than those of males. Almost one-third (32.7%) of females, but only 23.8% of males, had scores of 11 or 12 points (Table 6.9). Two-thirds of females (66.9%), but only just over half of males (54.9%) scored between 12 and 9 points. Performance at the lower end of the scale is similar to that in English and, to some degree, in Mathematics. On the Science examination, less than one quarter of females (22.5%) compared to one third of males (33.4%) obtained a score of 7 or lower.

Table 6.9. Percentages of Male and Female Candidates Achieving Various Scores on the Overall Performance Scale (OPS), With Mean OPS Scores, on the 1999 Junior Certificate Science Examination

Group	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*Mean (SD)*
% Males	8.1	15.7	17.3	13.8	11.6	17.0	11.9	3.3	1.2	8.7 (2.05)
% Females	12.1	20.6	19.8	14.4	10.6	12.3	7.7	2.1	0.4	9.3 (1.95)
% Total	10.0	18.0	18.5	14.1	11.1	14.8	9.9	2.7	0.8	9.0 (2.02)

Note. Row percentages may not sum to 100 due to rounding.

RELATIONSHIP BETWEEN PERFORMANCE ON THE JUNIOR CERTIFICATE EXAMINATION AND PISA

In this section, the relationship between students' performance on the Junior Certificate Examination and their performance on the PISA assessment (in 2000) is examined. It should be noted that the PISA cohort includes students who took the Junior Certificate Examination in 1999 (33.1% of the PISA cohort) as well as students who took the examination in 2000 (60.9% of the PISA cohort). Students who sat the examination in 1998, or who intended to sit it in 2001 were not included in analyses. Therefore Junior Certificate results are available for 94.1% for whom PISA reading and mathematical literacy scores are available; and for science, they are available for 80.5% of students who participated in the PISA assessment of scientific literacy. The percentage is lower for science because not all students took that subject for the Junior Certificate Examination.

Table 6.10. *Mean Overall Performance Scale (OPS) Scores in English, Mathematics, and Science, of Junior Certificate Examination Candidates in 1999 and 2000 (PISA Cohort)*

	Year	*N*	*Mean*	*SE*	*t*	*p*
English	1999	1,257	9.36	0.08	4.18	<.001
	2000	2360	9.03	0.07		
Mathematics	1999	707	8.33	0.12	3.24	.029
	2000	1,290	8.07	0.09		
Science	1999	571	8.18	0.18	1.90	.672
	2000	1,142	8.26	0.16		

Note. Degrees of freedom = number of variance strata in BRR variance estimation method = 80.

Students who sat Junior Certificate English and Mathematics in 2000 performed significantly better than those who sat in 1999, achieving, on average, approximately one-third of an Overall Performance Scale (OPS) score higher in English and one-quarter of an OPS score higher in Mathematics. The difference in the performance of the 1999 and 2000 candidates in Science is not significant (Table 6.10). Since our primary focus in this report is the PISA cohort, results from both years are combined into a single analysis (see Inset 6.2 for information on the interpretation of the relationship between performance on the Junior Certificate and PISA).

Inset 6.2. Interpreting Relationships Between Junior Certificate Overall Performance Scale (OPS) Scores and Performance on PISA

One possibility in evaluating the importance of a variable is to consider the magnitude of its regression coefficient. This approach is problematic because regression coefficients depend on the underlying scale of measurement. In an attempt to solve the problem of units of measurement, it has become common practice to provide standardized regression coefficients. Variables in the regression—both response and explanatory—are standardized by subtracting the mean and dividing by the standard deviation. *The standardized regression coefficients represent the change in the response for a change of one standard deviation in a predictor.*

One can thus transform raw (unstandardised) regression coefficients to describe the increase in Overall Performance Scale (OPS) scores on the Junior Certificate Examination associated with an increase of one standard deviation on the PISA literacy scales. For example, a one standard deviation increase on the combined reading literacy scale is associated with an increase of *(0.01360*93.58521)* = 1.27 points on the English OPS (see the table below).

	SD PISA	*Raw Coefficient*	*Increase in OPS per SD PISA*	*r*	*t*	*p*
English	93.58521	0.01360	1.27	.742	43.65	<.001

Table 6.11 shows the mean OPS scores of students for English, divided into high, medium and low scores on the PISA assessment[49], together with mean score differences for males and females. Students in the high category of the PISA reading literacy distribution had, on average, OPS scores that are almost three score points higher than the scores of students in the low category. This holds for both males and females. The magnitude of the

[49] PISA scale scores were classified as ‘high’, ‘medium’ and ‘low’ using the same procedure as for the continuous explanatory variables reported in Chapter 4. See Inset 4.2, point 2.

gender difference, which favours girls, is more pronounced in the high category (half an OPS score) than in the low category (0.3 of an OPS score). The difference between overall mean OPS scores of males and females is statistically significant, as are differences in the mean OPS scores associated with high, medium and low categories. The average OPS score difference between students in the high and low categories is more pronounced for PISA mathematical literacy (3.4 scores) than for reading literacy (2.8 OPS score points) (Table 6.12). Gender differences are less pronounced for mathematics than for reading, although females have slightly higher overall means and higher means in all three categories. However, the difference favouring females is statistically significant only for the medium category; there is no difference between the overall mean mathematics OPS scores of males and females.

Table 6.11. Mean Overall Performance Scale (OPS) Scores on Junior Certificate English of Students Categorised as Low, Medium, and High on the PISA Reading Literacy Scale, and Mean Score Differences, by Gender

	All		*Males*		*Females*		*Mean Score Differences (Reference Category: Female)*			
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Diff*	*SED*	*CI95%*	
High	10.37	0.04	10.06	0.07	10.59	0.04	–0.53	–0.08	**–0.37**	**–0.69**
Medium	9.36	0.05	9.14	0.06	9.52	0.10	–0.38	–0.12	**–0.15**	**–0.61**
Low	7.61	0.07	7.45	0.08	7.84	0.10	–0.39	0.13	**–0.64**	**–0.14**
All	9.15	0.06	8.77	0.08	9.53	0.07	–0.76	0.11	**–0.97**	**–0.55**

Note. Degrees of freedom = number of variance strata in BRR variance estimation method = 80. SED = standard error of the difference; CI95% = 95% confidence interval. Significant differences are in bold. Estimates are based on results of students for whom Junior Certificate Examination results in 1999 or 2000 were available. N = 3,625 (1,736 males and 1,889 females). N missing = 229.

Table 6.12. Mean Overall Performance Scale (OPS) Scores on Junior Certificate Mathematics of Students Categorised as Low, Medium, and High on the PISA Mathematical Literacy Scale, and Mean Score Differences, by Gender

	All		*Males*		*Females*		*Mean Score Differences (Reference Category: Female)*			
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Diff*	*SED*	*CI95%*	
High	9.75	0.08	9.65	0.12	9.87	0.11	–0.22	0.16	–0.54	0.10
Medium	8.12	0.08	7.91	0.10	8.32	0.10	–0.41	0.14	**–0.69**	**–0.13**
Low	6.41	0.10	6.24	0.15	6.53	0.12	–0.29	0.19	–0.67	0.09
All	8.14	0.08	8.09	0.11	8.18	0.10	–0.09	0.15	–0.39	0.21

Note. Degrees of freedom = number of variance strata in BRR variance estimation method = 80. SED = standard error of the difference; CI95% = 95% confidence interval. Significant differences are in bold. Estimates are based on results of students for whom Junior Certificate Examination results in 1999 or 2000 were available. N = 2,002 (951 males and 1,051 females). N missing = 126.

The difference between means of students in the low and high performance categories on the PISA scientific literacy scale is around three OPS scores (Table 6.13). Females perform better than males, especially in the middle third of the scale. The difference, though still favouring females, is lowest for the lowest third (0.2 of an OPS score), and not statistically significant. Gender differences associated with medium and overall OPS scores are statistically significant, and the difference for the high category is significant at the 10% level of confidence (Bonferroni 90% Confidence Interval: -0.557, -0.003).

Table 6.13. Mean Overall Performance Scale (OPS) Scores on Junior Certificate Science of Students Categorised as Low, Medium, and High on the PISA Scientific Literacy Scale, and Mean Score Differences, by Gender

	All		*Males*		*Females*		*Mean Score Differences (Reference Category: Female)*			
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Diff*	*SED*	*CI95%*	
High	10.58	0.06	10.44	0.09	10.72	0.14	–0.28	0.17	–0.61	0.05
Medium	9.25	0.08	8.97	0.13	9.52	0.10	–0.55	0.16	**–0.22**	**–0.88**
Low	7.68	0.10	7.56	0.12	7.84	0.14	–0.28	0.18	–0.65	0.09
All	9.30	0.08	9.06	0.10	9.58	0.09	–0.52	0.13	**–0.79**	**–0.25**

Note. Degrees of freedom = number of variance strata in BRR variance estimation method = 80. SED = standard error of the difference; CI95% = 95% confidence interval. Significant differences are in bold. Estimates are based on results of students for whom Junior Certificate Examination results in 1999 or 2000 were available. N = 1,720 (879 males and 841 females). N missing = 414.

An examination of correlations between students' OPS scores and their performance on PISA suggests a moderately strong relationship (Table 6.14; see Inset 6.2). In all three domains, they exceed .72. This suggests that, despite the differences in context, content, and method of assessment between PISA and the Junior Certificate Examinations, there is considerable overlap in the achievements assessed by the two measures.

Table 6.14. Regression Coefficients for the Linear Associations between Overall Performance Scale (OPS) Scores in English, Mathematics and Science, and PISA Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores

	Raw Coefficient	*SE*	*Increase in OPS per SD PISA**	*r*	*t*	*p*
English	0.014	0.0003	1.27	**.742**	43.65	<.001
Mathematics	0.018	0.0006	1.53	**.729**	32.86	<.001
Science**	0.014	0.0004	1.29	**.725**	36.65	<.001

Note. Significant correlations are in bold.

*These values are calculated using standard deviations and raw coefficients to five decimal places.

**Due to the fact that there are only two levels in science, the 9-point scale is equivalent to the 12-point scale for English and Mathematics.

THE PISA TEST-CURRICULUM RATING PROJECT

International studies of mathematics and science in the past have included measures of curriculum coverage. This may be done at the classroom level. Evidence of 'opportunity to learn' (OTL) has typically been obtained by asking teachers to examine each item and say whether most, some, or no students had had an opportunity to learn the topic covered in the item (implemented curriculum). Alternatively, curriculum experts were asked to indicate whether or not the content of each item appeared on the national curriculum (intended curriculum). Still other studies (see, for example, Schmidt et al., 1997) have included comparative analyses of textbooks and curriculum documents.

PISA did not include any OTL-type measures. This was justified on the basis that its focus is not on school-based learning, but on knowledge and skills needed by adults in society. Thus, it differs from TIMSS in which an effort was made to ensure that test items were appropriate for the students of all participating countries and reflected their current curriculum (Beaton et al., 1996a, b). In contrast, an OECD (1999b) publication which describes the aims of PISA and its assessment framework pointed out that

> Although the domains of reading literacy, mathematical literacy and scientific literacy correspond to school subjects, the OECD assessments will not primarily examine how well students have mastered the specific curriculum content. Rather, they aim at assessing the extent to which young people have acquired the wider knowledge and skills in these domains that they will need in adult life. (p. 9)

Despite this view, the PISA National Advisory Committee expressed an interest in analysing performance on PISA with reference to national syllabi. This led to the development and implementation of the PISA Text-Curriculum Rating Project (TCRP). Curriculum ratings can be used for a variety of purposes. They may identify similarities and differences between the content of the PISA assessment and the content of national curricula, or they may be used to analyse the amount of variance in student performance on PISA explained by the expected familiarity of students with the content of current syllabi. They can also provide information for a debate on the current status, strengths and weaknesses of syllabi in Ireland.

The aim of the TCRP was to develop a set of rating scales which are reliable, valid, and capable of capturing the extent and type of similarities and differences between PISA items and the types of questions students in third year of the Junior Cycle are exposed to[50], based on an examination of the intended curriculum at each level of the syllabus. The intended curriculum is defined in the same way as in TIMSS: *instruction and learning goals in English, mathematics and science as defined at the system level.*

Use of the rating scales does not address the issue that the syllabus may not be implemented as intended at all times. Nor does it take into account the fact that numerous factors, other than curriculum intent and the manner in which it is implemented, affect student achievements (the attained curriculum). There are also many aspects of the curriculum which are not tapped by the PISA assessment; this is especially true of the PISA 2000 minor domains, mathematics and science.

Procedure and Definition of Rating Scales

Three persons with extensive experience in each of the three subject areas carried out the curriculum rating exercise using a series of scales that are described in this section (see Tables 6.15, 6.16, and 6.17). The framework comprises a 3 x 3 matrix for reading and mathematics and a 4 x 2 matrix for science, containing the three or four aspects or dimensions of an item on which it was decided to focus: process, context/application, and format for reading; concept, context/application, and format for mathematics; and process, concept, context/application, and format for science. Each PISA item was rated for each aspect on its expected familiarity to a typical student at the three syllabus levels (or two in the case of science). Ratings range from 1 (not familiar) to 3 (very familiar). In this way, each reading and mathematics item received nine ratings, and each science item eight ratings. The scales are described in more detail in Appendix 6 (Section A6.1).

Initially, raters rated items independently, and items on which there was a lack of consensus were flagged. 'Consensus' was defined as the modal rating assigned to a particular scale at a particular syllabus level where there was either perfect agreement across the three raters *or* where there was disagreement, the difference did not exceed one scale point (e.g., 1, 1, 1; 2, 1, 2; 3, 3, 2, etc.). Thus, items which had received ratings on all three points of the scale (i.e., 1, 2, 3) were automatically flagged, as were items on which ratings differed by more than one scale point across raters (e.g., 3, 1, 1). Through discussion at a meeting of the raters, changes to one or more ratings assigned to each item on which there was a lack of consensus

[50] 3.4% of students assessed in PISA 2000 were in second year at the time of testing; 62.0% were in third year; 16.0% were in fourth year (transition year); and 18.7% were in fifth year.

were agreed upon, and flagged items were thus assigned a modal rating. (Table A6.3 in Appendix 6 shows the percentage of items in each of the three domains on which there was a lack of consensus.)

Table 6.15. Framework for the Test-Curriculum Rating Project: Reading Literacy Items

Aspect	*Junior Certificate Level*		
	Higher	*Ordinary*	*Foundation*
Process: How familiar would you expect the typical third year student to be with the specific reading process(es) underlying this item?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar
Context/Application: How familiar would you expect the typical third year student to be with the application of the specific reading process(es) underlying this item in the type of context (genre, text length, density, complexity) suggested by the item and stimulus text?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar
Format: How familiar would you expect the typical third year student to be with the application of the specific reading process(es) underlying this item in the type of format suggested by the item and stimulus text?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar

Table 6.16. Framework for the Test-Curriculum Rating Project: Mathematical Literacy Items

Aspect	*Junior Certificate Level*		
	Higher	*Ordinary*	*Foundation*
Concept: How familiar would you expect the typical third year student to be with the specific mathematical concept(s) underlying this item?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar
Context/Application: How familiar would you expect the typical third year student to be with the application of the specific mathematical concept(s) underlying this item in the type of context suggested by the item and stimulus text?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar
Format: How familiar would you expect the typical third year student to be with the application of the specific mathematical concept(s) underlying this item in the type of format suggested by the item and stimulus text?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar

Table 6.17. Framework for the Test-Curriculum Rating Project: Scientific Literacy Items

Aspect	*Junior Certificate Level*	
	Higher	*Ordinary*
Concept: How familiar would you expect the typical third year student to be with the specific scientific concept(s) underlying this item?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar
Process: How familiar would you expect the typical third year student to be with the specific scientific process(es) or type(s) of scientific reasoning underlying this item?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar
Context/Application: How familiar would you expect the typical third year student to be with the application of the specific scientific concept(s) underlying this item in the type of context suggested by the item and stimulus text?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar
Format: How familiar would you expect the typical third year student to be with the application of the specific scientific concept(s) underlying this item in the type of format suggested by the item and stimulus text?	Not/Somewhat/Very Familiar	Not/Somewhat/Very Familiar

Analysis at the Item Level: Reading

The percentages of reading literacy items which were rated at each point of the scale (not familiar, somewhat familiar, and very familiar) for each scale and syllabus are shown in Table 6.18 (Table A6.4, Appendix 6 gives a breakdown of these figures by rater).

At Higher and Ordinary levels, the process underlying the PISA items was rated as 'somewhat familiar' or 'very familiar' in over 90% of cases. Students at these two levels, it will be recalled, are expected to be competent in the application of a wide variety of reading skills. At Foundation level, the lower percentage of items (75%) rated as 'somewhat familiar' or 'very familiar' reflects the fact that some of the PISA items required students to make some higher-level and/or multi-stage inferences of the type that may be beyond the scope of Junior Certificate Foundation level English.

Table 6.18. Percentages of Ratings Assigned to Reading Literacy Items, by Scale and Syllabus Level (N items = 141)

	Not Familiar	*Somewhat Familiar*	*Very Familiar*
Process			
Higher	3.7	14.7	81.6
Ordinary	9.6	36.8	53.7
Foundation	25.0	47.1	27.9
Context/Application			
Higher	13.2	25.7	61.0
Ordinary	18.4	54.4	27.2
Foundation	50.7	47.1	2.2
Format			
Higher	50.0	15.4	34.6
Ordinary	52.2	23.5	24.3
Foundation	72.1	22.8	5.1

The familiarity of context/application ratings tended to drop as one moves from Higher to Ordinary to Foundation level. Since ratings on context/application for this domain were based on linguistic context (genre, text length, density), this pattern is not surprising and suggests that some of the texts used in the reading assessment are quite dense and complex compared to the types of text that Junior Cycle students, especially those studying the Foundation level course, are expected to work with. Some items that were rated 'not familiar' at all levels tended to be associated with more complex non-continuous texts. At all syllabus levels, 50% or more of items were rated 'not familiar' on format. These mostly comprised multiple-choice and complex multiple-choice items; students studying for the Junior Certificate Examination would be more accustomed to question formats requiring a short written or longer, essay-type response. Other items which were rated 'not familiar' on format included ones for which the response was contingent on the response to a previous item.

Analysis at the Item Level: Mathematics

The percentages of mathematical literacy items which were rated at each point of the scale (not familiar, somewhat familiar, and very familiar), for each scale and syllabus are shown in Table 6.19 (Table A6.5, Appendix 6 gives a breakdown of these figures by rater).

An examination of the expected familiarity of students with the mathematical concepts tapped by PISA items reveals a fairly even spread across the three scale points (not/ somewhat/very familiar). However, as one moves from Higher to Foundation level, the percentage of items rated as 'very familiar' drops from 28.1 to 9.4.

Table 6.19. Percentages of Ratings Assigned to Mathematical Literacy Items, by Scale and Syllabus Level (N items = 32)

	Not Familiar	*Somewhat Familiar*	*Very Familiar*
Concept			
Higher	31.3	40.6	28.1
Ordinary	34.4	46.9	18.8
Foundation	53.1	37.5	9.4
Context/Application			
Higher	71.9	28.1	0.0
Ordinary	75.0	25.0	0.0
Foundation	81.3	18.8	0.0
Format			
Higher	53.1	46.9	0.0
Ordinary	78.1	21.9	0.0
Foundation	71.9	28.1	0.0

The ratings for context/application are quite striking in that no item was rated 'very familiar' at any level. In fact, the manner in which the problem was contextualised was rated 'not familiar' in around three-quarters of items. This suggests a substantial difference between the PISA approach to contextualising items and the approach taken in the assessment of mathematics in Irish second-level schools. The ratings for format are similar to those for context/application. None of the PISA items was rated 'very familiar' on format, and around two-thirds were rated 'not familiar'. This occurred for two reasons. First, Irish students are not accustomed to multiple-choice and complex multiple-choice item formats (in the Junior Certificate Mathematics Examination). Second, Irish students are accustomed to straightforward exposition of problem material in questions with little or no redundant information or concrete contextualisation. However, the vast majority of PISA problems are contextualised, at least in the sense that there is a 'story setting' or concrete context.

Analysis at the Item Level: Science

Table 6.20 shows the classifications assigned to scientific literacy items according to their location in the Irish Junior Cycle science syllabus. It is clear that that the content of the assessment of scientific literacy does not match the Irish syllabus closely. One-third of the items (31.4%) comprise 'basic science' (core Biology, Chemistry or Physics). The PISA questions which correspond to Junior Cycle basic science comprised Biology items and some basic Earth science items.

The concepts underlying over two-fifths of the items (42.9%) are not covered in the Junior Certificate syllabus (core or options). There is also a high percentage of Earth science items (22.9%) relative to the emphasis on Earth science in the Junior Cycle science syllabus, which is an optional component, although approximately 68% of students answered the Earth science question in the 2000 Junior Certificate Examination. Only one PISA science item falls into the category of materials science and the remaining four Junior Cycle options (energy conversions, horticulture, food science, and electronics) are not represented at all in the PISA assessment.

Table 6.20. Percentages of PISA Scientific Literacy Items Classified by Location in the Irish Junior Cycle Science Syllabus (N items = 35)

Area of Irish Syllabus	*Percent of PISA Items*
Basic Science (core)	31.4
Earth Science option	22.9
Horticulture option	0.0
Materials Science option	2.9
Food Science option	0.0
Electronics option	0.0
Energy conversions option	0.0
Not in Irish Syllabus	42.9

Note. When deciding the location of each item within the syllabus, the concept underlying each item (rather than the process, format or context of application) received the greatest weighting.

The percentage of items which were rated at each point of the scale (not familiar, somewhat familiar, and very familiar), for each scale and syllabus are shown in Table 6.21 (Table A6.6, Appendix 6, gives a breakdown of these figures by rater).

Ratings for Higher and Ordinary syllabus levels are very similar on all four scales and, in fact, are identical except for three items on the concept scale. About half the PISA items on the concept scale are not likely to be familiar to Junior Cycle students. Some items assess knowledge of topics which are not covered until Senior Cycle (such as genetics), or indeed are not covered at all in science education at second level in Ireland (for example, the ozone layer).

Over 90% of the scientific literacy items tapped processes which raters thought students would be somewhat or very familiar with. Since the intended curriculum includes broad descriptions of the development of scientific reasoning and problem-solving, it was concluded that students studying either syllabus level should be somewhat familiar with most types of reasoning processes. However, the complexity of scientific reasoning was such in some of the PISA items that it was concluded that it was not likely that the process would have been covered by teachers, or acquired by students on their own.

Table 6.21. Percentages of Ratings Assigned to Scientific Literacy Items, by Scale and Syllabus Level (N items = 35)

	Not Familiar	*Somewhat Familiar*	*Very Familiar*
Concept			
Higher	48.6	22.9	28.6
Ordinary	54.3	22.9	22.9
Process			
Higher	8.6	74.3	17.1
Ordinary	8.6	74.3	17.1
Context/Application			
Higher	80.0	11.4	8.6
Ordinary	80.0	11.4	8.6
Format			
Higher	42.9	22.9	34.3
Ordinary	42.9	22.9	34.3

About four-fifths of scientific literacy items were rated as unfamiliar on the context/application scale. The reasons for this are quite similar to the reasons that the context/application of many mathematics items was judged unfamiliar. Students taking Junior Certificate Science are not accustomed to reading through large amounts of text, to extracting relevant (scientific) information or ignoring redundant (non-scientific) information. Rather, the emphasis is on the learning and application of fundamental science concepts.

Junior Certificate Examination papers contain some questions which require students to underline the correct response — one short word or phrase out of four or five — in response to a question. This item format is similar to that used in the PISA science multiple-choice items which have single words or short phrases as the answer options. Therefore all questions of this type were rated 'somewhat familiar'. However, multiple-choice items with longer more complex answer options and complex (multi-part) multiple-choice items were deemed 'not familiar'. Many of the other question formats, such as writing a short response or labelling a diagram, were considered somewhat or very familiar to Irish students.

Booklet (Student) Level Analyses

While ratings of PISA assessment items and information on the percentages of students who correctly responded to items are of interest, summing ratings of PISA assessment items at the booklet level allows us to go a step further and to link curriculum ratings with the performance of students. To do this, the mean of each curriculum rating for each of the clusters (nine reading, four mathematics, and four science) was calculated. Next, the mean of each cluster mean was calculated for each of the nine PISA assessment booklets (see Table 6.22 and Appendix 6, Tables A6.7 and A6.8). In addition to calculating booklet level means for each scale for each domain, it was also necessary to ensure that each student was assigned booklet-level curriculum scale means appropriate to his or her level of study of each subject. Each student received only one rating for each scale depending on the level of the syllabus he or she was studying at the time of the PISA assessment and the PISA booklet he or she completed. Students for whom syllabus level data were missing, or who said they did not study a subject, were excluded from subsequent analyses.

Table 6.22. Test Design for PISA 2000

Booklet ID	*Reading*	*Mathematics*	*Science*
1	R1, R2, R4	M1, M2	—
2	R2, R3, R5	—	S1, S2
3	R3, R4, R6	M3, M4	—
4	R4, R5, R7	—	S3, S4
5	R1, R5, R6	M2, M3	—
6	R2, R6, R7	—	S2, S3
7	R1, R3, R7, R8	—	—
8	R8, R9	M2, M4	S1, S3
9	R8, R9	M1, M3	S2, S4

Note. The cells show the cluster IDs, where R1 is cluster one of the PISA reading literacy items, M1 is cluster one of the mathematical literacy items, and S1 is cluster one of the PISA scientific literacy items, etc. Each reading cluster is designed to take approximately 30 minutes to complete, while each mathematics and science cluster is designed to take approximately 15 minutes to complete.

Table 6.23 presents the correlations and standardised coefficients (see Inset 6.2) associated with each scale and performance on the PISA reading, mathematical, and scientific literacy scales. All three reading scales are moderately strongly associated with performance on PISA (range of r = .46 to .55), with the process and context scales being slightly higher. This indicates that students tend to do better on items which were rated more familiar on all three reading curriculum scales. For mathematics, the curriculum scale most strongly associated with achievement on PISA was the concept scale (r = .48); correlations between achievement on PISA mathematics and the context (.23) and format (.20) scales were weaker.

Correlations between the curriculum rating scales and performance on PISA science are weaker again. In fact, the correlation between context and performance on PISA science is not significant (r = –.01; p = .352). The strongest correlate of performance on PISA science is the concept scale (r = .19).

Table 6.23. Standardised Coefficients for the Linear Associations (10 Separate Models) Between Curriculum Rating Scales, and Performance on Reading Literacy, Mathematical Literacy, and Scientific Literacy

	Raw Coefficient	*SE*	*Increase in PISA per SD Curric Scale**	*r*	*t*	*p*
Reading Literacy						
Process Scale	304.28	9.23	51.41	**.549**	32.961	<.001
Context Scale	259.57	8.10	50.91	**.544**	32.028	<.001
Format Scale	286.02	10.35	42.84	**.458**	27.627	<.001
Mathematical Literacy						
Concept Scale	330.93	12.93	40.13	**.480**	25.593	<.001
Context Scale	173.36	16.19	19.28	**.231**	10.711	<.001
Format Scale	177.05	18.37	16.69	**.200**	9.636	<.001
Scientific Literacy						
Process Scale	127.40	65.59	4.50	**.049**	1.942	.026
Concept Scale	100.26	12.90	17.83	**.194**	7.775	<.001
Context Scale	–12.10	31.91	-0.88	**–.010**	-0.038	.352
Format Scale	59.55	20.17	5.43	**.059**	2.952	.002

Note. Significant correlations are in bold. Percent missing: 1.1% (for Reading); 1.2% (for Mathematics); and 15.8% (for Science).
*These values are calculated using standard deviations and raw coefficients to five decimal places.

To examine the dimensionality of the curriculum scales, a principal components analysis for each domain was carried out (see Appendix 6, Table A6.9 for factor loadings and details of the percentage of variance explained). The curriculum scales for both reading and mathematics form a single scale. In the case of science, the format scale does not load on the same factor as the other three scales. Hence, a science component consisting of only process, concept, and context was constructed.

Table 6.24 shows the mean scores for PISA reading, mathematics, and science by high, medium and low combined curriculum ratings, together with associated mean score differences.[51]

Students who took a booklet with reading items which, on average, had a low curriculum familiarity rating scored, on average, 122.5 scale points lower than students who took a booklet with a high curriculum familiarity rating. The corresponding difference for mathematics was 69.8 scale points, and for science somewhat smaller at 24.2 scale points. Differences between groups are significant in all cases, except for the comparison between high and medium familiarity for science.

[51] Curriculum ratings were classified as ‘high’, ‘medium’ and ‘low’ using the same procedure as for the continuous explanatory variables reported in Chapter 4. See Inset 4.2, point 2.

Table 6.24. Mean Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Combined Curriculum Rating Scales

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Combined Curriculum Scale												
Low Familiarity	31.9	32.3	447.0	3.44	27.7	28.1	460.5	4.48	34.2	40.6	514.7	4.25
Medium Familiarity	22.4	22.6	556.9	2.83	36.8	37.3	511.8	2.82	21.5	25.5	513.4	5.48
High Familiarity	44.6	45.1	570.5	2.22	34.2	34.7	530.7	3.38	28.5	33.9	538.9	3.77
Missing	1.1	0.0	441.3	16.84	1.2	0.0	423.1	19.12	15.8	0.0	464.2	7.84
All	98.9	100.0	526.7	3.24	98.8	100.0	502.9	2.72	84.2	100.0	513.4	3.18
Mean Score Differences (all groups compared)												
	Diff	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*		*Diff*	*SED*	*BCI95%*	
Low–Medium	–109.9	4.46	**–120.7**	**–99.0**	–51.3	5.29	**–64.2**	**–38.3**	1.3	6.94	–15.7	18.2
High–Medium	13.6	3.60	**4.8**	**22.4**	18.9	4.40	**8.1**	**29.6**	25.5	6.65	**9.2**	**41.7**
High–Low	–123.5	4.09	**–132.9**	**–114.1**	–70.2	5.61	**–83.0**	**–57.4**	–24.2	5.68	**–37.2**	**–11.2**
Missing–Medium	–115.6	17.07	**–157.4**	**–73.9**	–88.7	19.32	**–136.0**	**–41.5**	–49.2	9.57	**–72.6**	**–25.8**

Note. Degrees of freedom = number of variance strata in BRR variance estimation method = 80.
Total Ns: Reading Literacy = 3854; Mathematical Literacy = 2128; Scientific Literacy = 2134.
%T = percentage of all students; %A = percent of available students; Diff = difference between means; SED = standard error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval.

Table 6.25 shows the correlations between each combined curriculum scale[52] and performance on PISA reading, mathematics, and science. The association between the curriculum scale and performance on PISA remains strongest for reading (r = .56) and weakest for science (r = .13) (see Inset 6.2).

Table 6.25. Standardised Coefficients for the Linear Associations Between Combined Curriculum Rating Scales, and Combined Reading Literacy, Mathematical Literacy and Scientific Literacy

	Raw Coefficient	*SE*	*Increase in PISA per SD Curric Scale**	*r*	*t*	*p*
Reading	52.51	1.60	52.51	**.561**	32.75	<.001
Mathematics	32.47	1.66	32.47	**.388**	19.57	<.001
Science**	11.63	2.33	11.63	**.127**	4.99	<.001

Note. Significant correlations are highlighted in bold.
*These values are calculated using standard deviations and raw coefficients to five decimal places.
**The format scale was not used in the construction of the combined curriculum scale for science.

CONCLUSION

This chapter presented an overview of current issues relating to the Junior Certificate Examination in English, Mathematics and Science, as well as some data on student performance. In an examination of relationships between performance on the Junior Certificate Examinations and performance on PISA, correlations were found to exceed .72 for all three domains, indicating substantial overlap between the skills tapped in the two assessments. Further analyses in which students were categorised in terms of their PISA literacy scores (into high, medium, and low) reinforce the conclusion that, by and large, students that performed well in the PISA assessment also performed well in the Junior

[52] Combined scale mean for each subject = 0.0; SD = 1.00.

Certificate Examination. Similarly, poor performance in one assessment was matched by poor performance in the other.

Gender differences in performance on both the Junior Certificate English Examination and the PISA assessment of reading literacy were consistent with patterns found in IEA/RLS. On both assessments, females significantly outperformed males. However, while the performance of males and females on the Junior Certificate Mathematics Examination did not differ, males did significantly better than females on the PISA mathematics assessment. This might be due to the high proportion of geometry and measurement items in PISA, areas which were associated with the largest gender differences in the performance of Irish second-year students in TIMSS; and the high emphasis on problem-solving, which tends to favour males. Females significantly outperformed males on the 1999 Junior Certificate Science Examination but not on the PISA science assessment. The latter is somewhat surprising, considering the relatively high level of reading required for the PISA science assessment (see Chapter 1). On the other hand, the performance of females on the PISA science assessment is perhaps surprising, given that 23.8% of students in all girls schools who participated in PISA did not study science at Junior Cycle level.

Procedures to estimate the extent to which students who had followed Junior Cycle syllabi in English, Mathematics, and Science would have been familiar with the PISA assessment items revealed that, in the case of reading literacy, the process underlying over 90% of items should have been either 'somewhat familiar' or 'very familiar' to students who had taken Higher or Ordinary level courses. Only 75% of items, however, would have been familiar to Foundation level students. The familiarity of context/application ratings also tended to drop from Higher to Ordinary to Foundation level, while at all syllabus levels, the format of half or more of the PISA reading items was rated 'not familiar'.

Mathematical concepts tapped by PISA items exhibited a fairly even spread across the three scale points from the very familiar to the not familiar. However, as one moved from Higher to Foundation level, the percentage of items rated as 'very familiar' dropped. No mathematical literacy item was rated 'very familiar' at any level on the context scale. This suggests a substantial difference between the PISA and Junior Cycle approaches to contextualising items. None of the PISA mathematics items was rated 'very familiar' on format, and around two-thirds were rated 'not familiar'.

On the basis of our analyses, about half of the PISA scientific literacy items would not have been familiar to Junior Cycle students. Some items assessed knowledge of scientific topics which are not covered until Senior Cycle, or not at all in second-level syllabi. Over 90% of the PISA science items were judged to involve processes that students would have been somewhat or very familiar with. As in the case of mathematics, about four-fifths of items rated on the science context/application scale were considered unfamiliar, while the format of about three-fifths of items was rated somewhat or very familiar.

All three curriculum scales for reading correlate moderately strongly with achievement on PISA reading literacy (.46 or higher), while in the case of mathematical literacy, achievement is more strongly correlated with the concept scale (.48) than with the context (.23) or format (.23) scales. Correlations between the curriculum scales for science and achievement on PISA scientific literacy are weaker, although a correlation of .19 between the concept scale and PISA science was found. Thus, while the process, contextualisation and format of the PISA items are associated with performance on PISA reading literacy, performance in mathematical literacy is more closely associated with the concept underlying items than with context or format. Links between curriculum ratings of items and performance are weaker for scientific literacy than for reading and mathematical literacy, although once again, the concept underlying the items is more closely associated with performance on the items than process, contextualisation, or format.

When relationships between performance on PISA and ratings on the intended curriculum (Junior Cycle syllabi) are compared with relationships between performance on PISA and the attained curriculum (performance on Junior Certificate English, Mathematics and Science Examinations), a number of points emerge. First, it is clear, in the case of reading literacy, that the relationships in both cases are moderately strong. As noted in the review of the Junior Certificate English syllabus, there are parallels between Junior Cycle syllabus and PISA reading, most notably with respect to the reading skills or processes assessed (retrieve information, interpret text, and reflect and evaluate text). It is reasonable to conclude that despite the differences between the assessments, most notably in the relative emphasis on non-continuous texts and differences in response formats, PISA reading literacy and Junior Certificate English are assessing similar reading skills. The relatively poor performance of boys on both the PISA reading assessment and the Junior Certificate English Examination, confirming the patterns of earlier international assessments, must be a cause for concern.

Second, the fact that performance on PISA mathematical literacy is more closely related to the ratings of items on the concept scale than to ratings on the context/application and format scales suggests that familiarity with the concept underlying an item is more important than how the item is contextualised, or the format in which the question is asked. Students who have a good understanding of mathematical concepts seem to be able to apply the concepts to non-familiar contexts. Students in Ireland performed less well on the mathematical literacy assessment in PISA than on the reading and scientific literacy assessments. This can be attributed, in part at least, to substantial differences between what students at Junior Cycle are taught and what PISA mathematics assesses. Whether the Junior Cycle should be assessing mathematical skills that are similar to the PISA mathematics assessment is an issue that merits further consideration.

Third, although relationships between performance on PISA scientific literacy and on the Junior Certificate Science Examination are moderately strong and comparable to those for both reading and mathematics, relationships between performance on PISA scientific and curriculum familiarity ratings are weak. This suggests that the match between performance on PISA and the intended science curriculum is weaker than the match between performance on PISA science and the attained curriculum. Indeed, the concepts underlying two-fifths of PISA science items are not included in the Junior Cycle syllabus, either as core or optional components. As noted in Chapter 1, the readability indices (grade level) for PISA scientific literacy are higher than those for PISA reading literacy. Further, student performance on PISA reading correlates more highly with PISA science than with PISA mathematics. It could be argued that some of the PISA science items assess generic reading comprehension and/or problem solving skills rather than purely scientific concepts.

7

Summary and Conclusions

SUMMARY

The Programme for International Student Assessment (PISA) was administered to students in 28 OECD member countries (including Ireland) and in four additional countries in Spring/Autumn 2000. In Ireland, 3,854 15-year old students in 139 schools participated. In line with the literacy-based approach to assessment underpinning PISA, tests of literacy were administered to students in one major domain (reading), and in two minor domains (mathematics and science).

In the reading literacy assessment, students were tested on their understanding of a range of texts, both continuous (descriptions, narrations and essays) and non-continuous (charts, diagrams, maps, forms and tables). The outcomes are reported in terms of scores on an overall (combined) scale, and on three subscales – Retrieving information, Interpreting information in texts, and Reflecting on and Evaluating the content and structure of texts. Outcomes are also reported in terms of proficiency levels on the combined scale and on the three subscales.

Ireland achieved the fifth highest mean score among the 27 OECD countries that met agreed criteria on school and student participation levels. Just one country (Finland) achieved a significantly higher mean. The countries with mean scores not significantly different from Ireland's are Australia, Canada, Japan, Korea, Sweden, the United Kingdom, and New Zealand. The performance of Irish students on the Retrieve and Interpret subscales is about the same as on the test as a whole. Again, only students in Finland achieved significantly higher mean scores. Ireland ranked third on the Reflect/Evaluate subscale, with a mean score that does not differ significantly from Canada, the highest scoring country on the subscale. Ireland's mean scores on the combined scale and on the three subscales are significantly higher than the corresponding OECD country average scores.

Five proficiency levels were identified for the combined reading literacy scale and for each of the reading subscales. An additional category, 'below Level 1', was added to accommodate students whose performance did not meet the criteria for inclusion at Level 1 (the lowest level) ~~(Level 1)~~. In Ireland, 11.0% of students are at Level 1 or below; 17.9% at Level 2; 29.7% at Level 3; 27.1% at Level 4; and 14.2% at Level 5. Finland, the country with the highest mean score, has 6.9% at Level 1 or below and 18.5% at Level 5. The percentages of Irish students represented at each level on the Retrieve and Interpret subscales are broadly similar to the percentages on the combined reading literacy scale. Performance on the Reflect/Evaluate subscale is marginally better, with 44.0% of students achieving Levels 4 and 5, compared with an OECD average of 33.4%. The combined reading literacy scores of Irish students at the national 10th and 90th percentiles are among the highest in the OECD.

The assessment of mathematical literacy was less comprehensive than the assessment of reading literacy. Only two areas were included (Change and Growth, and Shape and Space; these encompassed aspects of Measurement, Algebra, Functions, Geometry, and Statistics). Performance was reported in terms of scores on a single scale only. The performance of Irish students on the scale does not differ significantly from the OECD country average. Ireland ranked 15th of 27 OECD countries. The highest scoring country (Japan) had a mean score that is over half a standard deviation higher than the mean of Irish students, while the United Kingdom achieved a mean score that is one quarter of a standard deviation higher. However, Irish students at the (national) 10th percentile achieved a score that is significantly higher than the OECD country average score at that marker, and ranked 14th. Irish students at the 90th percentile achieved a score that is below the corresponding OECD country average, and ranked 20th, indicating a relatively poor performance by higher-achieving students.

The assessment of scientific literacy, which was also less comprehensive than for reading literacy, sought to measure students' ability to apply a range of scientific processes including recognising questions, identifying evidence/data, and drawing and evaluating conclusions. While some content areas, such as Atmospheric Change, Earth and Universe, Energy Transfer, and Ecosystems, were well represented, others, such as Biodiversity, Chemical and Physical Change, and Physiological Change, were not. Like mathematical literacy, achievement in scientific literacy was reported on a single scale only.

The mean score of Irish students on the scientific literacy scale is significantly higher than the OECD country average. Ireland ranks 9th overall. Students in six countries, including the UK, Korea, and Japan, achieved significantly higher mean scores than Ireland, while students in five other countries, including Austria and Sweden, achieved mean scores that are not significantly different. Thus, Ireland did comparatively better in scientific literacy than in mathematical literacy, but relatively less well than in reading literacy. The scientific literacy score of Irish students at the (national) 10th percentile is above the corresponding OECD average. However, Irish students at the (national) 90th percentile achieved a score that is not significantly different from the OECD average at that point.

School and student questionnaires were administered to obtain information on a range of variables. These included student characteristics (such as gender, home educational climate, learning processes, reading habits, and attitudes to reading), and school characteristics (such as enrolment size, learning climate, and resource availability).

Female students outperformed male students on the combined reading literacy scale (by over two-fifths of a standard deviation), ~~by~~ and on each of the reading subscales. The gender difference is largest on the Reflect/Evaluate scale (over one-third of a standard deviation). Male students are more strongly represented than females at the lowest proficiency levels on the PISA combined scale and subscales, while the reverse pattern is apparent at the highest levels. Male students performed significantly better than female students (by one-sixth of a standard deviation) on the assessment of mathematical literacy. The gender ~~difference~~ difference is not statistically significant for scientific literacy.

Home background variables representing combined parents' socioeconomic status (SES), combined parents' educational level, home educational resources (access to a dictionary, a desk/place to study and textbooks) and number of books in the student's home (a measure of home educational environment) were correlated with achievement in the three assessment domains. Students in lone parent households achieved mean scores that are significantly lower (by about a quarter of a standard deviation in each assessment domain) than students not in lone parent households. There is an inverse relationship between the number of siblings in students' families and their literacy scores in all three domains.

The student reading habits and attitudes most strongly associated with combined reading literacy are attitude towards reading, frequency of leisure reading, diversity (range) of materials read, and frequency of borrowing library books. Students who hold positive attitudes towards reading achieved a mean combined reading literacy score that is one standard deviation higher than that of students who hold a negative attitude. The relationship between some of these variables and achievement is curvilinear rather than linear. For example, moderate amounts of leisure reading (30 to 60 minutes per day) are more strongly associated with achievement than larger amounts.

A number of other student characteristics were found to be associated with achievement. Students identified as being at risk of dropping out of school before doing the Leaving Certificate Examination (14.3% of students) achieved a mean combined reading literacy score that is over one standard deviation lower than that of students not deemed to be at risk. Students at risk of dropout also achieved mean scores in mathematical and scientific literacy that are substantially lower than the mean scores of students not at risk. Students attending learning support classes in English achieved a mean score that is ~~over~~over one standard deviation lower than that of students not attending such classes, and also performed less well in mathematical and scientific literacy. Students who did not study science at Junior Cycle level performed less well (by almost three-quarters of a standard deviation) on the assessment of scientific literacy than students who studied science. However, the mean scientific literacy score of students who studied Ordinary level science at Junior Cycle is not significantly different from the mean score of students who did not study science at Junior Cycle. Students who completed homework mostly or always on time~~ on most occasions or always~~ did significantly better in all three assessment domains than students who completed homework on time on a less frequent basis. Students who had access to a calculator during the~~ PISA~~ mathematical literacy assessment (27.3% of students) achieved a mean score that is over one quarter of a standard deviation higher than that of students without access.

Several school characteristics were found to be associated with achievement~~ on PISA~~ ~~including~~ and included the following: school enrolment size (students in larger schools achieved significantly higher mean scores in combined reading literacy than students in smaller schools; differences in mathematical and scientific literacy were not significant); school type (students in community/comprehensive schools achieved significantly higher mean scores than students in vocational schools in the three assessment domains, and significantly lower scores than students in secondary schools in reading and scientific literacy, but not mathematical literacy); disadvantaged status (students in schools designated as disadvantaged achieved mean scores in the three assessment domains that are about one-~~-~~half of a standard deviation ~~higher~~ lower than the mean scores of students in non-designated schools); and gender composition (students in all-boys schools achieved significantly higher mean scores than students in co-educational schools in mathematical and scientific literacy but not in reading literacy, while students in all-girls schools outperformed students in co-educational schools on reading literacy, but not mathematical or scientific literacy).

Students in small classes did significantly less well (by about one-quarter of a standard deviation) in all three assessment domains than students in average sized classes, while no differences in mean achievement were observed between students in average-sized and large-sized classes in any of the domains. Achievement is not associated with different levels of student-teacher ratio, except in the case of mathematical literacy, where students in schools with a high student-teacher ratio did significantly better than students with a medium student-teacher ratio. Students in schools with high levels of negative student behaviour (a measure provided by school principals) did significantly less well on combined reading literacy and scientific literacy than students in schools with average levels. The mean mathematical literacy scores of students in schools with varying levels of negative disciplinary climate (a measure provided by individual students, but aggregated to the school level) do not differ significantly, while students in schools with a high negative disciplinary climate had significantly lower mean scores in reading and scientific literacy, compared with students in schools with an average negative disciplinary climate.

Since many of the variables that correlated with achievement are themselves inter-related, regression-based procedures were used to help improve inferences about the relative contributions of such variables to achievement at both school and student levels.

The percentage of between-school variance in Irish student achievement is 17.8% for combined reading literacy; 11.4% for mathematical literacy; and 14.1% for scientific literacy. These estimates are well below the corresponding OECD country average percentages and suggest that, compared to schools in other countries, Irish schools are relatively homogeneous with respect to achievement, but there is considerable variation in achievement within schools.

Hierarchical linear models were developed for all three domains in which student performance was assessed. The final model for reading literacy explains 77.8% of between-school variance and 44.2% of within-school variance. The corresponding model for mathematical literacy explains 78.8% of between-school variance and 31.9% of within-school variance, while that for scientific literacy explains 74.5% of between-school variance and 34.1% of within-school variance. The larger proportion of within-school variance explained in the final reading model may be attributed to the inclusion in the model of a number of variables that are specific to reading literacy, including attitude towards reading and frequency of leisure reading.

The model for reading literacy includes school-level variables (disciplinary climate, school type and disadvantaged status), student-level variables (gender, socioeconomic status, number of siblings, index of books in the home, dropout risk, frequency of absence from school, completion of homework on time, grade level, frequency of leisure reading, and attitude to reading), and a variable reflecting the interaction between gender and index of books in the home. This model confirms the associations of a number of variables with achievement and indicates their estimated contributions to students' scores. The variables include attendance at a vocational rather than a community/comprehensive school (–20.4 points or 0.22 of a standard deviation); attendance at a school designated as being educationally disadvantaged (–22.3 points or almost one quarter of a standard deviation); and dropout risk (–54.4 points, or over half a standard deviation).

Since the model is additive, it is possible to estimate the contributions of combinations of variables. For example, ~~it can be estimated that~~ a student attending a vocational school that is designated as disadvantaged and who is at risk of dropping out of school ~~will~~ is expected to score, on average, 97.1 points lower in reading literacy~~, than~~ compared with a student attending a community/comprehensive school that is not designated, and who is not at risk of dropping out. The (average) contribution of socioeconomic status (SES) ranges from +25.9 points (one quarter of a standard deviation) for students categorised as having high SES (i.e., those in the top third of the distribution of SES scores) to +3.0 points for students categorised as having low SES (those in the bottom third).

The hierarchical linear models for mathematical literacy and scientific literacy are~~were~~ less complex than that for reading literacy. School type and disadvantaged status are the only school-level variables in these models. However, together they account for sizeable proportions of between-school variance. Both models also include parents' combined ~~educational attainment, student lone-parent status~~socioeconomic status, number of siblings, index of books in the home, grade level, completion of homework, and dropout risk. ~~In the mathematical literacy model, there was a significant interaction between gender and books in the home that was broadly similar to that found in the reading literacy model.~~

In the model for mathematical literacy, the~~The~~ effect of socioeconomic status is estimated to amount to ~~+47.7~~+41.7 score points (just over half a ~~two~~ standard deviation~~s~~) for high SES students, +30.84 for medium SES students, and +20.1 for low SES students.

Hence, the contribution of this variable is comparatively greater than for reading literacy, even though combined parental educational attainment is also included in the model.

In addition to the variables included in the model for mathematical literacy, the model for scientific literacy includes a variable describing whether or not a student studied science at school. The contribution of studying science to students' scores on the scientific literacy test is +43.1 points (almost half a standard deviation).

Correlations between the grades of students on the Junior Certificate Examination (represented as scores on an Overall Performance Scale in English, Mathematics and Science) and their scores on the PISA assessment domains are moderately strong. The correlation between Junior Certificate English and PISA reading literacy is .74; the correlations between Junior Certificate Mathematics and PISA mathematical literacy, and between Junior Certificate Science and PISA scientific literacy, are both .73.

In an examination of links between aspects of the Junior Cycle syllabus/Junior Certificate Examination and PISA, curriculum experts in Ireland indicated that the processes underlying the majority of PISA reading literacy items would be very familiar to students studying Higher and Ordinary level syllabi, and that, for most students, the contexts in which items were presented would be very familiar or familiar. It was concluded that the format of the items would be unfamiliar to a majority of students at all three syllabus levels.

Mathematics curriculum experts concluded that students taking Higher and Ordinary level Mathematics would be unfamiliar with the concepts underlying about one-third of the PISA mathematical literacy items, and that Foundation level students would be unfamiliar with the concepts underlying about half the items. It was concluded that students at all syllabus levels would be unfamiliar with the context of application in which around four-fifths of the items were presented, and would also be unfamiliar with the format of at least half the items.

Curriculum experts in science concluded that, while most students would at least be familiar (if not very familiar) with the processes underpinning the PISA scientific literacy items, students at both Higher and Ordinary levels would be unfamiliar with the concepts underlying about half of the items and with the contexts in which about four-fifths of items were presented. The formats of two-fifths of the items were judged to be unfamiliar to students.

Correlations between students' combined reading literacy scores and the three curriculum rating scales (familiarity with process, context, and format) suggest that all three scales correlate moderately strongly with achievement (range = .46 to .55). In contrast, the scale most closely associated with achievement in mathematical literacy is the familiarity with concept scale ($r = .48$); correlations associated with the context (.23) and format (.20) scales are lower. In the case of scientific literacy, the familiarity with concept scale is also most closely associated with achievement ($r = .19$), while correlations associated with the process, context and format scales are considerably smaller (range = –.01 to .06). For mathematical literacy, at least, it appears that understanding of the concept underlying an item is more important than how the item is contextualised, or the format in which the item is presented.

In the report, comparisons are drawn between the performance of Irish students on PISA and in other international studies of educational achievement, taking into account such factors as assessment frameworks, item formats, and criteria associated with proficiency levels. Some preliminary implications of the outcomes of PISA for education in Ireland are offered.

CONCLUSIONS

Given the relatively poor performance of Irish 14-year olds in the IEA Reading Literacy Study (IEA/RLS), and the apparently poor performance of Irish adults in the International Adult Literacy Survey (IALS), one might not have expected that Irish students would have done so well on the PISA reading literacy assessment.

The discrepancy between the performance of Irish students on IEA/RLS and PISA is noteworthy. In IEA~~RE~~/RLS, Irish 14-year olds achieved a ranking of 16th of 19 OECD countries, and a mean score close to that of the international median country. In PISA, Irish 15-year olds achieved a ranking of 5th of 27 OECD countries and a mean score that is~~was~~ significantly higher than the OECD country average. The relatively strong performance of Irish students on reading literacy in PISA may be attributed to a number of factors. First, the PISA reading literacy framework and tests were broadly compatible with the Junior Certificate syllabus, and with the Junior Certificate English Examination~~ in English~~. Second, the PISA assessment included items which required students to reflect on and evaluate the content and form of texts, and Irish students, notably females, did particularly well on these. Such items were not as strongly represented in IEA/RLS. Third, the PISA assessment included a greater proportion of open constructed-response items, to which students could provide divergent responses and viewpoints.

In a comparison of the outcomes on PISA and IALS, a discrepancy is evident; the proportion of Irish students scoring at the lowest levels of proficiency (Level 1 and below) on the PISA reading literacy scale is much lower than the proportion of adults who scored at lowest level (Level 1) on the IALS scale. The converse is true at the higher proficiency levels. A variety of explanations may be offered to account for the discrepancy. These relate to ~~differences in response rates (just 60% of selected Irish adults responded in IALS); ~~the educational attainment of respondents (over 20%~~a proportion~~ of adults in IALS had not completed lower second level); differences in the reading processes tapped by assessments (IALS focused more strongly on locating specific information, while PISA included a focus on reflecting on and evaluating texts); and differences in the criteria used to define cut points for proficiency levels (IALS used more ~~conservative ~~stringent criteria).

A finding that is common to recent national assessments at primary level and the PISA assessment of reading literacy is that a proportion of students in the educational system experience serious literacy difficulties. In PISA, the percentage achieving Level 1 or below on the combined reading literacy scale was ~~eleven~~11.0. While this figure is lower than the international mean (17.9%), it is nevertheless a cause for concern. It is of interest in this context to observe that in Korea, where the overall mean score did not differ significantly from that in Ireland, just 5.7% of students scored at Level 1 or below, while in Finland, the country with the highest overall mean score, the corresponding estimate was 6.9%. Hence, the needs of very low achievers in Irish schools continue to be a cause of concern.

In considering the achievements of Irish students in PISA mathematical literacy, it should be borne in mind that the assessment focused on a relatively narrow range of content and skills, in line with its status as a minor domain in 2000. Nevertheless, although the mean score for Irish students is not significantly different from the international mean, and therefore is consistent with the outcomes for second-~~-~~level students in earlier studies such as IAEP II and TIMSS, a number of observations about the performance of Irish students in PISA can be made.

First, their performance ~~of Irish students ~~relative to the performance of students in other countries was poorer in mathematical literacy than in reading or scientific literacy. Second, the performance in mathematical literacy of higher achieving students in Ireland

(~~with~~defined as ~~–~~scores at the 90th percentile) was poorer than in countries with mean achievement scores that do not significantly differ from the Irish mean.

A number of reasons may be put forward to explain why Irish students did less well on mathematical literacy than on reading or scientific literacy. First, at least one-third of items assessed concepts that do not figure prominently in the Junior Cycle mathematics syllabi, and so may have been unfamiliar to some ~~Irish~~ students. Second, almost one-half of the items assessed aspects of M~~m~~easurement and G~~g~~eometry, which are areas in which Irish students have done relatively poorly in earlier international assessments. Third, as indicated in Chapter 6, expert raters judged that Irish students would have been unfamiliar with between one-third and one-half of the concepts underlying the items. Fourth~~ly~~, expert raters judged that at least 70% of the items were presented in contexts ('problem scenarios') that would have been unfamiliar to Irish students (in general, mathematics in the Junior Certificate E~~e~~xamination is assessed using context-free items, or items that are embedded in short scenarios that do not contain redundant information; questions that call for the application of problem solving skills in contexts such as those found in PISA are less prominent). Finally, none of the PISA mathematical literacy items was presented in a format with which Irish students would have been 'very familiar'. In fact, three-quarters of items were judged by raters to be in formats that would have been unfamiliar to students studying ~~he~~ Ordinary or Foundation level Junior Cycle syllabi.

Having said this, i~~I~~t should be acknowledged that information on the extent to which PISA mathematical literacy items reflected curricula in other countries is not available. Students elsewhere may also have been faced with items that were unfamiliar to them, though Australia, a country in which approaches consistent with realistic mathematics education have been implemented, did particularly well in PISA mathematical literacy.

~~Another factor that~~Other factors may have affected Ireland's performance in mathematics. One relates to access to calculators during the assessment. Irish students who ~~had access (on the basis that their principal teachers indicated that access was normally available during mathematics classes)~~used a calculator in PISA achieved a mean score that was 25.2 points (~~one quarter~~0.30 of a standard deviation) higher than students ~~without access~~who did not use one. Comparable data for other countries are not available. It might be hypothesised that students with calculators progressed more quickly through the items, and produced more accurate answers than students without calculators.

Since mathematics was a minor domain in PISA 2000, it would be premature to suggest that the Junior Cycle mathematics syllabi should be modified to include a stronger emphasis on 'realistic mathematics', and 'real world' problem-~~–~~solving tasks. PISA 2003 ~~should~~ will provide a more comprehensive assessment of students' mathematical literacy over a broader range of mathematical themes and topics, and should allow for a stronger statement on the appropriateness of current syllabi and approaches to assessment.

Irish 15-year olds did well on the PISA assessment of scientific literacy, relative to the performance of Irish second-~~–~~level students in earlier international assessments of science. In the IAEP II assessment, Irish 13-year olds achieved a mean score that was below the international average, while in the more recent TIMSS, students in second year achieved a mean score that did not differ significantly from the OECD average. In PISA, however, Irish students achieved a mean score that was significantly higher than the OECD average, and ranked 9th of 27 countries.

While this relatively good performance is welcome, it cannot be concluded that it represents a level of achievement in science that is superior to that in earlier studies. Unlike earlier assessments, PISA took a literacy-based approach to the assessment of science, focusing on students' ability to recognise questions, identify evidence and data, and draw conclusions. Hence, s~~S~~cientific knowledge was not assessed in the same way as in TIMSS, and certain aspects of scientific knowledge (such as Physics and Chemistry) are not as strongly represented in PISA as they were in TIMSS. PISA emphasises Life and Earth sciences to a greater extent than TIMSS.

Two additional factors need to be considered in interpreting performance on the PISA assessment of scientific literacy: similarities between it and the PISA assessment of reading literacy, and the inclusion of students in the assessment who did not study science at school.

The correlation between the scores of Irish students who attempted both the PISA reading literacy and scientific literacy assessments is .90 (see Chapter 3). An examination of the assessment materials in the scientific literacy test indicates that they contain several long passages of text, ~~some~~ with readability levels that are more difficult, on average, than those ~~of passages~~ in the reading literacy assessment (see Chapter 1 and Appendix 1). To the extent that Irish students did very well in reading literacy, it might be expected that they would do as well in scientific literacy. However, the fact that they did not suggests that they may lack ~~a~~ knowledge of the scientific concepts that were assessed. This hypothesis is in line with the observations of expert raters who indicated that just over 40% of the PISA items could not be located in the Junior Cycle syllabi, and that the concepts underpinning half of the PISA items would not have been familiar to Irish students.

The extent to which the mean score of Irish students was affected by the inclusion in the assessment of students who did not take science as a subject at Junior Cycle level is not clear. Students who had studied science (88.2%) achieved a mean score on the assessment that was some two-~~-~~thirds of a standard deviation higher than the mean score of students who had not (see Chapter 4). The magnitude of this difference was somewhat reduced (to just under a half of a standard deviation) in the final hierarchical linear model for scientific literacy (see Chapter 5) after other variables such as socioeconomic status and school type had been taken into account; however, it is still considerable. Unfortunately, no information is available on the proportions of students in other countries who ~~took~~ do not take science as a subject at lower second level. Hence, there is little point in speculating on how Ireland's relative standing might differ if all students had studied science. It may be noted, however, that students in the United Kingdom, where science is an obligatory subject in the national curricula, both at primary and lower second levels, achieved a significantly higher mean score than Irish students (532.0 compared with 513.4), though the ~~issue of~~extent of the overlap between the assessments surrounding national curricula in the UK and the PISA assessment may also be relevant.

A particularly interesting finding to emerge from~~form~~ the analysis of the Irish data on scientific literacy was that, while students who studied Junior Cycle science at higher level achieved a significantly higher mean score on PISA scientific literacy than students who studied the subject at ordinary level, the difference between the mean scores of students who studied science at Ordinary level and those who did not study science was not statistically significant. ~~However, in~~Differences between the achievements of Higher and Ordinary level students may be interpreted in terms of the complexity of scientific reasoning required to respond to the assessment items. It will be recalled from Chapter 3 that lower scores on the scientific literacy scale are associated with simpler processes such as the use of common science knowledge in drawing conclusions, while higher scores are associated with more complex processes such as the selection of relevant information from competing data, or the application of detailed chains of reasoning, in drawing or evaluating conclusions. ~~the absence of information on the general ability of students taking Ordinary level science, and those not taking science, this finding is difficult to interpret.~~

Between-school variance amounted to less than 18% of the total variance in achievement of Irish students in the three PISA domains. ~~PISA~~ In the earlier IEA/RLS, the figure for 14-year olds was 48%, while in TIMSS, figures for second year students were 50%

for mathematics and 38% for science. However, comparisons across these studies are difficult due to differences in sampling procedures in the three studies.

The hierarchical linear models for the three PISA assessment domains ~~confirmed~~ suggested ~~sizeable~~ substantial differences between the achievements of students in community/comprehensive schools and vocational schools (in favour of the former), and smaller differences between the achievements of students in community/comprehensive and secondary schools in reading literacy and scientific literacy (in favour of the latter).

The negative contribution of ~~the variable,~~ school disadvantaged status~~,~~ was also confirmed by the hierarchical linear models for all three domains. In reading literacy, for example, the contribution of disadvantaged status to achievement is –22.3 ~~score~~ points (~~one fifth~~almost one-quarter of a standard deviation). Though less than half the size of the contribution of dropout risk (a student-level variable), it is nevertheless considerable.

Whereas the hierarchical linear models explain ~~a~~ sizeable proportions of between-school differences in achievement, they explain less of the within-school differences. One reason for this is the cross-sectional nature of the data. A second is the absence from the models of variables that are less relevant to policy such as student ~~intellectual~~ academic ability ~~or current grade level~~.

The three models give rise to some unanticipated results. These include the interaction between gender and the index of books in the home in the models for reading and scientific literacy; the interaction between gender and lone parent status in the mathematical literacy model; and the effect of the inclusion of attitude to reading on~~and~~ frequency of leisure reading in the reading literacy model. These findings may point to problems in measuring particular variables (for example, the number of books in students' homes) or to a need to develop a more complex view of these phenomena.

The ~~PISA~~ results also suggest that an appraisal of the proportions of students taking Higher, Ordinary, and Foundation level Junior Certificate ~~exams~~ Examinations in English and mathematics may be appropriate. While 62.9% of Junior Certificate Examination students in 1999 took the Higher level English paper, only 36.0% took the Higher level mathematics paper. Given the moderately strong association between the level at which a course was studied and performance on PISA, it seems reasonable to hypothesise that, if a greater proportion of students were to study Higher level mathematics at Junior Cycle level~~, and attempted the Higher level paper in mathematics~~, overall achievement in mathematical literacy would improve. Any proposals to increase the proportion of students taking Higher level mathematics would, of course, raise issues about the appropriateness of course content and pedagogical methods.

A consideration of the proportions of students taking the Foundation level examinations in Junior Certificate English and mathematics is also relevant. In 1999, just 4.3% of students attempted the Foundation level paper in English, while 12.7% took mathematics at this level. While this discrepancy may be associated with the different proportions attempting the Higher level courses in the two subjects, the conclusion drawn in this and other studies that about 10% of students in second-level schools have serious reading difficulties might lead one to expect that the proportion taking the Foundation level examination in English would be greater. The absence of a separate syllabus for Foundation level English and, by implication, an appropriate theoretical model and procedures specific to the needs of students taking the course, may mean that the distinction between Foundation and Ordinary levels is often blurred. Relevant to this is the observation that some students who scored at Level 1 or below on PISA achieved a grade of D or higher on Ordinary level English in the Junior Certificate Examination.

IMPLICATIONS

In considering implications that arise from the study, three points should be kept in mind. First, since mathematical and scientific literacy were minor domains in PISA 2000, the implications put forward in relation to these domains should be regarded as more tentative than those put forward for reading literacy. Relationships can be confirmed and stronger implications drawn as these aspects of literacy assume the status of major assessment domains in future cycles of PISA.

Second, many variables associated with achievement at age 15 (for example, reading habits and attitudes, or the effects of home educational environment) may have cumulative effects on student achievement over several years. Hence, several of the implications may be considered relevant to students at primary as well as second level~~s~~.

Third, the hierarchical linear models presented in this report represent an initial exploration of the data. The models need to be extended and refined as specific issues are addressed in more detail.

Reading Literacy

1. *Addressing low achievement in reading literacy*. The percentage of Irish students achieving at Level 1 or below on the PISA combined reading literacy scale (11.0%) is a matter of concern, given that students scoring at~~ this~~ Level 1 have only the most basic skills assessed by PISA, and those scoring below it do not even have these minimal skills. In the 1998 National Assessment of Reading in f~~F~~ifth c~~C~~lass (primary level), one student in ten was identified as having reading difficulties of a serious nature (Cosgrove et al., 2000). These findings suggest a need to implement focused school-wide and individual programmes in second-~~-~~level schools that are designed to target students with serious reading difficulties, and, where such programmes are already in place (e.g., learning support), to examine their effectiveness~~ in addressing the needs of students with serious reading difficulties~~. A focused approach to addressing the needs of students with very low achievement in reading literacy might also serve to increase their achievement in mathematics and science, where language skills are also implicated.
2. *Choice of Foundation Level English courses/examinations.* The discrepancy between the percentage of students in PISA identified as having serious reading difficulties (11.0%) and the percentage of Junior Cycle students taking the Foundation Level examination in English in the Junior Certificate Examination (4.2% in 1999) suggests that more students might benefit from studying the Foundation Level course in English~~, and taking the Foundation Level Junior Certificate Examination in that subject~~. The absence of a separate syllabus for Foundation level English may also need to be addressed so that the purpose and focus of the course are clearer to teachers and students.
3. *Gender differences in reading literacy.* Female students in Ireland achieved a mean score on reading literacy that was ~~one quarter~~almost one-third of a standard deviation higher than that of male students, while male students were more strongly represented than female students at the lower levels of the reading proficiency scale and subscales. Such findings are consistent with those of earlier international studies in which female students outperformed male students at primary and second levels. However, the final hierarchical linear model for reading literacy indicates that the effects of gender, and any attempts to address them, should not be considered independently of their interactions with other explanatory variables (for example, the

index of books in the home, ~~–~~a measure of home educational resources~~– in the current study~~).

Mathematical Literacy

4. *Links between Junior Cycle syllabus, Junior Certificate E~~e~~xamination and performance on PISA mathematical literacy.* Future revisions of the Junior Cycle mathematics syllabus and Junior Certificate examination should take into account differences between the content of the Junior Cycle mathematics/Junior Certificate Examination~~,~~ and the content and format of the PISA assessment of mathematical literacy. It may be that the present syllabi/exams do not pay sufficient attention to developing and assessing students' problem-~~-~~solving skills in the context of solving real-world problems in a variety of relevant settings.

5. *Performance of higher-achieving students in mathematical literacy*. The relatively poor performance of Irish students scoring at the 90th percentile in the~~ PISA~~ mathematical literacy assessment needs to be examined further in light of the differences between the Junior Cycle syllabus/Junior Certificate E~~e~~xamination in mathematics and the PISA assessment. As indicated above, the need to place a stronger emphasis on the development problem-~~-~~solving skills in a broader range of applied contexts may be indicated. Other factors that might affect the performance of higher achievers, including their motivation and the expectations of their teachers, could be addressed in PISA 2003.

6. *Representation of students in Higher level mathematics courses*. Implications of the discrepancy between the percentages of Irish students taking English (62.9% in 1999) and mathematics (32.0%) at Higher level in the Junior Certificate E~~e~~xamination need to be examined in light of the strong performance of students in reading literacy in PISA, relative to their performance in mathematics.

7. *Gender differences in mathematical literacy*. Although male students achieved a significantly higher mean score than female students on PISA mathematical literacy, the size of the difference (12.9 points, or one-sixth of a standard deviation) is smaller than the difference in favour of female students in reading literacy. The final hierarchical linear model for mathematical literacy indicates that the effects of gender might~~must~~ be considered in conjunction with lone ~~-~~parent status. ~~One particular group, f~~Female students in lone parent households~~,~~ would appear to be particularly at risk of lower achievement in mathematics.

8. *Calculator usage in mathematics*. The finding that Irish students with access to calculators during the PISA assessment achieved a significantly higher mean score than students without access warrants further investigation, not least because PISA mathematical literacy items were designed to be calculator neutral. However, such investigation is hampered by a lack of comparable international data on calculator usage ~~during PISA~~in the assessment and a large number of missing cases (11.3%) in the Irish dataset.

Scientific Literacy

9. *Importance of scientific content knowledge.* Given that Irish students did comparatively well in ~~PISA~~ reading literacy, the lower performance in science relative to students in countries with similar levels of reading literacy suggests that some Irish students lack scientific content knowledge. This, coupled with the view of Irish curriculum experts that the content (but not the processes) in about one-~~-~~half of the PISA scientific literacy items would not have been presented during coursework in

Junior Cycle science, suggests that current syllabi may lack aspects of scientific content that PISA considers to be important for students' future lives.

10. *Study of science*. The relatively poor performance on the ~~PISA~~ assessment of scientific literacy of Irish students who had not studied science at Junior Cycle is a matter of concern, and suggests that these students may lack important scientific content knowledge. The implementation of a curriculum in science at primary level, which is currently in the planning stage, should go some way towards increasing students' content knowledge~~ in science~~, though the related question of whether a core module in science should be included in the curriculum for all students at Junior Cycle level also merits consideration.

11. *Gender differences in scientific literacy*. No overall difference between Irish male and female students emerged on the test of scientific literacy. This contrasts with the outcomes of earlier international studies in which male students outperformed female students, and may be due to the stronger representation of items dealing with Life and Earth sciences in PISA, and the relative absence of items in Physics (on which Irish male students outperformed female students in TIMSS) and Chemistry. The PISA findings should not induce complacency regarding gender differences in science.

School-Level Variables

12. *School type.* In most cases, there are large differences in average achievement in reading, mathematical, and scientific literacy, between students in the three types of schools (secondary, community/comprehensive, and vocational), even after other variables such as school disadvantaged status and student SES are taken into account. This suggests a need to examine how students select schools, how schools select students, and the effects of selection on student achievement.

13. *Disadvantaged status.* Together with school type (and disciplinary climate in the model of reading literacy), school disadvantaged status explains a large proportion of between-school variance in achievement. Programmes to address educational disadvantage are already in place, including the Department of Education and Science's *Disadvantaged Areas Schools Scheme* and related initiatives. There is a need to examine whether such programmes (at both primary and second levels) focus strongly enough on developing language and literacy skills, or whether their main effects are in other areas.

Student-Level Variables

14. *Drop-out risk*. The large negative coefficients associated with students who are at risk of dropping out of school prior to completion of upper second level in the hierarchical models for reading, mathematical and scientific literacy reinforce the view that at-risk students should be identified as early as possible (in primary school) to achieve continuity in addressing their needs in the transition to second-level schooling. The outcomes of pilot interventions such as the *8-15 Early School Leavers' Initiative*, the *Junior Certificate Schools Programme,* and the *Stay in School Retention Initiative,* that incorporate strategies to identify and prevent student dropout, ~~e~~ may be instructive in this regard. The finding that the effect of drop-out risk on achievement in reading literacy is not constant across schools supports the establishment of pilot intervention programmes in schools attended by the greatest numbers of at-risk students.

15. *Home educational environment.* The ~~variable~~ index of books in the home, which may be taken as a measure of home educational environment, was found to make a

contribution to achievement in all three assessment domains even when related variables such as parents' educational attainment, socioeconomic status, and parental engagement in students' learning are taken into account. This finding can be taken as confirmation of the importance of securing home ~~environment~~ involvement in programmes to address the needs of students in disadvantaged backgrounds.

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Appendix 1

A1.1. PISA 2000 Sample Items

The following texts and items have been adapted from the international report. Percent correct scores have been weighted by the population weights. The missing category comprises not answered and multiple (unscorable) responses. The percent correct score is based on the percentage of all students who completed an assessment booklet containing the item, both those who did and did not attempt the item. Between 22.2% and 33.3% of students attempted each item. This is due to the fact that there are nine test booklets and each item appeared in two or three of the nine booklets. The overall percent correct for partial credit items is the weighted sum of the partially correct and fully correct percentages. The scale score and the proficiency level corresponding to each item are also presented. An interpretation of these scores may be found in Chapter 3. The key to open-ended items has been abbreviated.

Reading Literacy

Unit: Graffiti *(Context: Public; Text Structure: Continuous; Text Type: Argumentative)*

I'm simmering with anger as the school wall is cleaned and repainted for the fourth time to get rid of graffiti. Creativity is admirable but people should find ways to express themselves that do not inflict extra costs upon society.

Why do you spoil the reputation of young people by painting graffiti where it's forbidden? Professional artists do not hang their paintings in the streets, do they? Instead they seek funding and gain fame through legal exhibitions.

In my opinion, buildings, fences and park benches are works of art in themselves. It's really pathetic to spoil this architecture with graffiti and what's more, the method destroys the ozone layer. Really, I can't understand why these criminal artists bother as their 'artistic works' are just removed from sight over and over again.

Helen

There is no accounting for taste. Society is full of communication and advertising. Company logos, shop names. Large intrusive posters on the streets. Are they acceptable? Yes, mostly. Is graffiti acceptable? Some people say yes, some no.

Who pays the price for graffiti? Who is ultimately paying the price for advertisements? Correct. The consumer.

Have the people who put up billboards asked your permission? No. Should graffiti painters do so then? Isn't it all just a question of communication – your own name, the names of gangs and large works of art in the street?

Think about the striped and chequered clothes that appeared in the stores a few years ago. And ski wear. The patterns and colours were stolen directly from the flowery concrete walls. It's quite amusing that these patterns and colours are accepted and admired but that graffiti in the same style is considered dreadful.

Times are hard for art.

Sophie

Question 1

Aspect: Developing an interpretation; multiple choice
PISA Scale Score = 421. Level 2
The purpose of each of these letters is to
A explain what graffiti is.
B* present an opinion about graffiti.
C demonstrate the popularity of graffiti.
D tell people how much is spent removing graffiti.

Percent Choosing Each Response		
	Ireland	*OECD*
A	4.2	3.7
B*	80.7	76.7
C	2.3	3.4
D	10.2	11.8
Missing	2.5	4.5

*=Key

Question 2

Aspect: Developing an interpretation; open constructed response
PISA Scale Score = 542. Level 3
Why does Sophie refer to advertising?

Percent Choosing Each Response			
	Ireland	*OECD*	*Key*
Incorrect	35.4	36.3	Insufficient; vague; inaccurate comprehension
Correct	59.7	53.4	Recognise a comparison being drawn
Missing	4.9	10.2	

Question 3

Aspect: Reflecting on text; open constructed response
PISA Scale Score = 471. Level 2
Which of the two letter writers do you agree with?
Explain your answer by using your own words to refer to what is said in one or both of the letters.

Percent Choosing Each Response			
	Ireland	*OECD*	*Key*
Incorrect	18.2	25.4	Direct quote; insufficient; vague; inaccurate comprehension
Correct	78.7	67.8	Point of view with reference to one or both letters
Missing	3.1	6.8	

Question 4

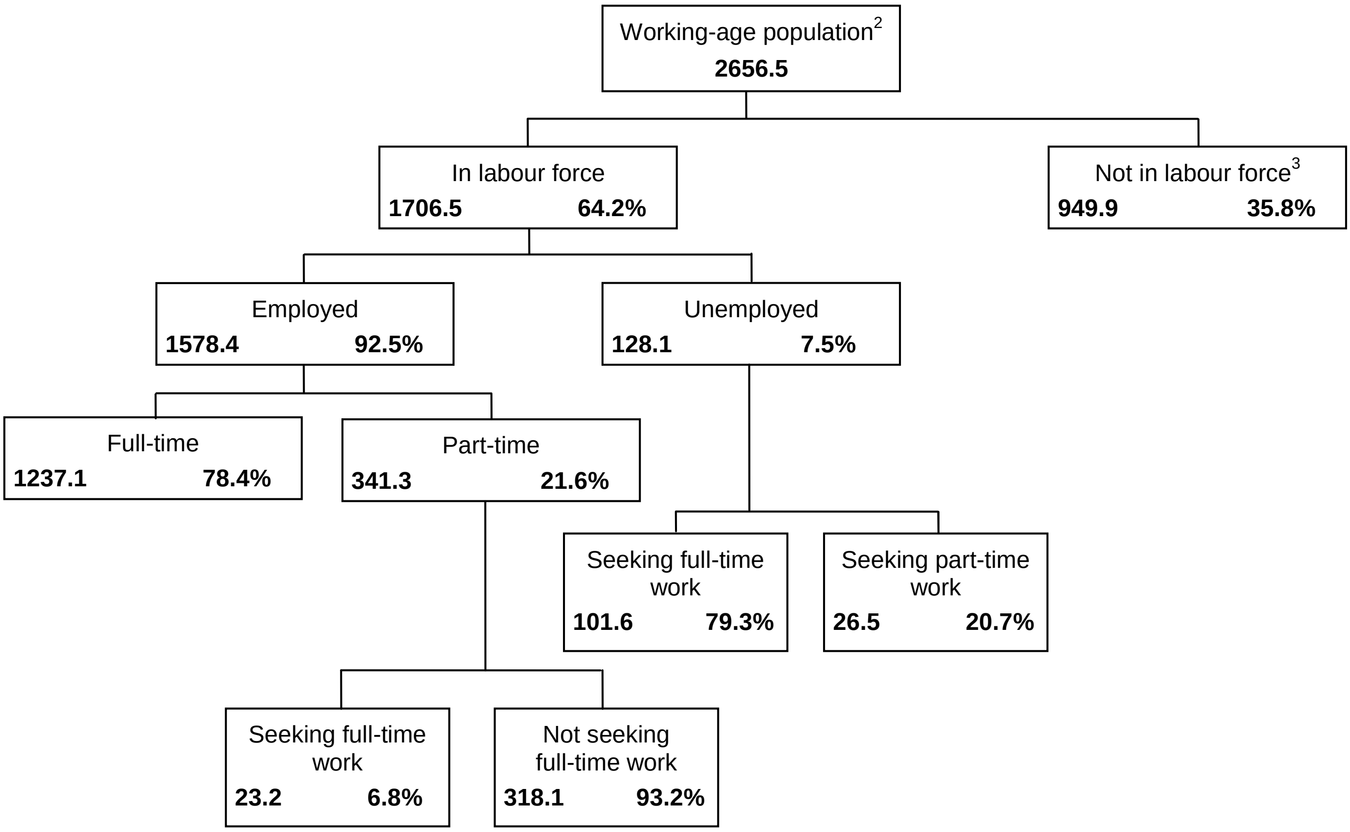
Aspect: Reflecting on text; open constructed response
PISA Scale Score = 581. Level 4
We can talk about **what** a letter says (its content).
We can talk about **the way** a letter is written (its style).
Regardless of which letter you agree with, in your opinion, which is the better letter?
Explain your answer by referring to the way one or both letters are written.

Percent Choosing Each Response			
	Ireland	*OECD*	*Key*
Incorrect	45.2	40.8	Judge in terms of agree; disagree; insufficient explanation
Correct	47.9	45.2	Reference to style and form
Missing	6.9	13.9	

Unit: Labour *(Context: Educational; Text Structure: Non-continuous: Text Type: Schematics)*

The tree diagram below shows the structure of a country's labour force or "working-age population". The total population of the country in 1995 was about 3.4 million.

The Labour Force Structure year ended 31 March 1995 (000s)[1]



Notes

1. Numbers of people are given in thousands (000s).
2. The working-age population is defined as people between the ages of 15 and 65.
3. People "Not in labour force" are those not actively seeking work and/or not available for work.

Question 5

Aspect: Developing an interpretation; multiple choice
PISA Scale Score = 477. Level 2
What are the two main groups into which the working-age population is divided?

A Employed and unemployed.
B Of working age and not of working age.
C Full-time workers and part-time workers.
D* In the labour force and not in the labour force.

Percent Choosing Each Response	*Ireland*	*OECD*
A	22.4	16.0
B	3.2	7.6
C	11.8	8.1
D*	58.7	62.9
Missing	3.8	5.4

*=Key

Question 6

Aspect: Retrieving information; short response
PISA Scale Score = 631. Level 5 (fully correct). PISA Scale Score=485. Level 3 (partially correct).
How many people of working age are not in the labour force?
(Write the number, not the percentage.)
Percent Choosing Each Response

	Ireland	*OECD*	*Key*
Incorrect	21.8	24.6	Other responses; incorrect numbers
Partially Correct	43.8	37.0	000s in title; footnote not integrated correctly
Fully Correct	28.5	27.9	Indicates number in diagram and integrates 000s
Correct	50.4	46.4	
Missing	5.9	10.5	

Question 7

Aspect: Developing an interpretation; complex multiple choice
PISA Scale Score = 727. Level 5 (fully correct). PISA Scale Score=473. Level 2 (partially correct).
In which part of the tree diagram, if any, would each of the people listed in the table below be included?
Show your answer by placing a cross in the correct box in the table.
The first one has been done for you.

	"In labour force: employed"	"In labour force: unem-ployed"	"Not in labour force"	Not included in any category
A part-time waiter, aged 35	☒	☐	☐	☐
A business woman, aged 43, who works a sixty-hour week	*	☐	☐	☐
A full-time student, aged 21	☐	☐	*	☐
A man, aged 28, who recently sold his shop and is looking for work	☐	*	☐	☐
A woman, aged 55, who has never worked or wanted to work outside the home	☐	☐	*	☐
A grandmother, aged 80, who still works a few hours a day at the family's market stall	☐	☐	☐	*

Percent Choosing Each Response		
	Ireland	*OECD*
Incorrect	30.0	30.3
Partially correct (3 or 4 correct)	54.0	52.0
Fully correct (5 Correct)	14.5	13.4
Overall Correct	41.5	39.4
Missing	1.5	4.3

*=Key

Question 8

Aspect: Reflecting on text; complex multiple choice

PISA Scale Score = 445. Level 2

Suppose that information about the labour force was presented in a tree diagram like this every year.

Listed below are four features of the tree diagram.

Show whether or not you would expect these features to change from year to year by circling either 'Change' or 'No change'. The first one has been done for you

Features of Tree Diagram	Answer
The labels in each box (*e.g.* "In labour force")	Change / No change
The percentages (*e.g.* "64.2%")	Change* / No change
The numbers (*e.g.* "2656.5")	Change* / No change
The footnotes under the tree diagram	Change / No change*

Percent Choosing Each Response		
	Ireland	*OECD*
Incorrect (2 or fewer correct)	22.5	24.0
Correct (3 correct)	74.1	69.1
Missing	3.4	5.9

*=Key

Question 9

Aspect: Reflecting on text; multiple choice

PISA Scale Score = 486. Level 3

The information about the labour force structure is presented as a tree diagram, but it could have been presented in a number of other ways, such as a written description, a pie chart, a graph or a table.

The tree diagram was probably chosen because it is especially useful for showing

A changes over time.

B the size of the country's total population.

C* categories within each group.

D the size of each group.

Percent Choosing Each Response		
	Ireland	*OECD*
A	10.0	10.2
B	3.9	7.8
C*	70.0	62.4
D	12.3	13.2
Missing	3.9	6.5

*=Key

Scientific Police Weapons

A murder has been committed but the suspect denies everything. He claims not to know the victim. He says he never knew him, never went near him, never touched him… The police and the judge are convinced that he is not telling the truth. But how to prove it?

At the crime scene, investigators have gathered every possible shred of evidence imaginable: fibres from fabrics, hairs, finger marks, cigarette ends…The few hairs found on the victim's jacket are red. And they look strangely like the suspect's. If it could be proven that these hairs are indeed his, this would be evidence that he had in fact met the victim.

Every individual is unique

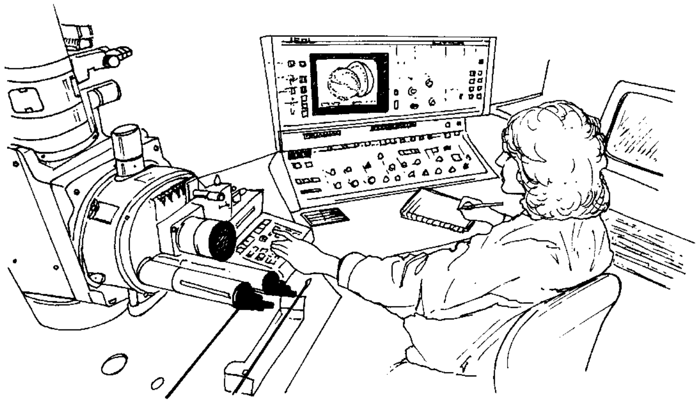
Specialists set to work. They examine some cells at the root of these hairs and some of the suspect's blood cells. In the nucleus of each cell in our bodies there is DNA. What is it? DNA is like a necklace made of two twisted strings of pearls. Imagine that these pearls come in four different colours and that thousands of coloured pearls (which make up a gene) are strung in a very specific order. In each individual this order is exactly the same in all the cells in the body: those of the hair roots as well as those of the big toe, those of the liver and those of the stomach or blood. But the order of the pearls varies from one person to another. Given the number of pearls strung in this way, there is very little chance of two people having the same DNA, with the exception of identical twins. Unique to each individual, DNA is thus a sort of genetic identity card.

Geneticists are therefore able to compare the suspect's genetic identity card (determined from his blood) with that of the person with the red hair. If the genetic card is the same, they will know that the suspect did in fact go near the victim he said he'd never met.

Just one piece of evidence

More and more often in cases of sexual assault, murder, theft or other crimes, the police are having genetic analyses done. Why? To try to find evidence of contact between two people, two objects or a person and an object. Proving such contact is often very useful to the investigation. But it does not necessarily provide proof of a crime. It is just one piece of evidence amongst many others.

Anne Versailles



Microscope in a police laboratory

We are made up of billions of cells

Every living thing is made up of lots of cells. A cell is very small indeed. It can also be said to be microscopic because it can only be seen using a microscope which magnifies it many times. Each cell has an outer membrane and a nucleus in which the DNA is found.

Genetic what?

DNA is made up of a number of genes, each consisting of thousands of "pearls". Together these genes form the genetic identity card of a person.

How is the genetic identity card revealed?

The geneticist takes the few cells from the base of the hairs found on the victim, or from the saliva left on a cigarette end. S/he puts them into a product which destroys everything around the DNA of the cells. S/he then does the same thing with some cells from the suspect's blood. The DNA is then specially prepared for analysis. After this, it is placed in a special gel and an electric current is passed through the gel. After a few hours, this produces stripes similar to a bar code (like the ones on things we buy) which are visible under a special lamp. The bar code of the suspect's DNA is then compared with that of the hairs found on the victim.

Question 10

Aspect: Developing an interpretation; multiple choice
PISA Scale Score = 515. Level 3
To explain the structure of DNA, the author talks about a pearl necklace.
How do these pearl necklaces vary from one individual to another?
A They vary in length.
B* The order of the pearls is different.
C The number of necklaces is different.
D The colour of the pearls is different.

Percent Choosing Each Response		
	Ireland	*OECD*
A	2.6	3.8
B*	50.0	61.4
C	4.0	5.3
D	41.5	25.5
Missing	1.9	3.9

*=Key

Question 11

Aspect: Developing an interpretation; multiple choice
PISA Scale Score = 518. Level 3
What is the purpose of the box headed “How is the genetic identity card revealed”?
To explain
A what DNA is.
B what a bar code is.
C* how cells are analysed to find the pattern of DNA.
D how it can be proved that a crime has been committed.

Percent Choosing Each Response		
	Ireland	*OECD*
A	7.5	9.9
B	4.4	4.7
C*	63.7	59.4
D	22.4	22.5
Missing	2.0	3.5

*=Key

Question 12

Aspect: Developing an interpretation; multiple choice
PISA Scale Score = 406. Level 2
What is the author’s main aim?
A To warn.
B To amuse.
C* To inform.
D To convince.

Percent Choosing Each Response		
	Ireland	*OECD*
A	8.9	6.4
B	1.3	1.3
C*	76.7	80.5
D	12.1	8.9
Missing	1.0	2.9

*=Key

Question 13

Aspect: Developing an interpretation; multiple choice

PISA Scale Score = 402. Level 2.

The end of the introduction (the first shaded section) says: “But how to prove it?”
According to the passage, investigators try to find an answer to this question by

A interrogating witnesses.

B* carrying out genetic analyses.

C interrogating the suspect thoroughly.

D going over all the results of the investigation again.

Percent Choosing Each Response

	Ireland	*OECD*
A	2.3	3.8
B*	85.0	80.8
C	4.2	5.1
D	6.8	6.8
Missing	1.7	3.5

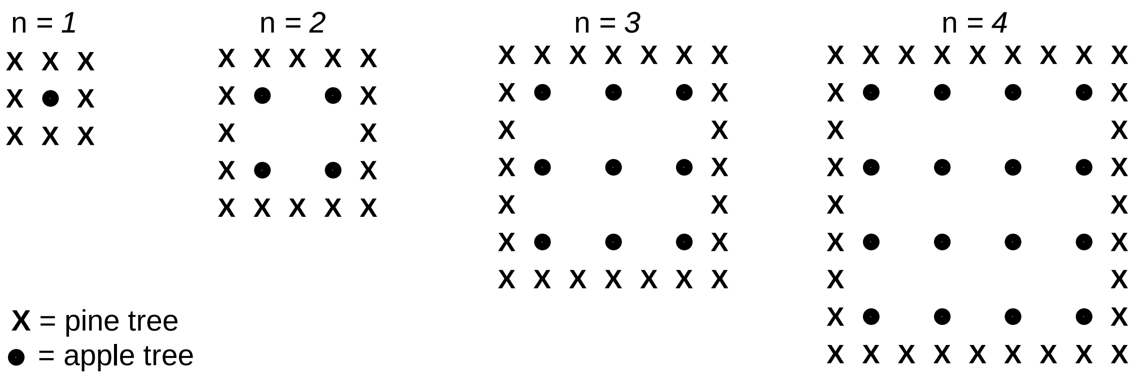
*=Key

Mathematical Literacy

Unit: Apples *(Context: Educational; Big Idea: Growth and Change; Maths Strand: Algebra)*

A farmer plants apple trees in a square pattern. In order to protect the trees against the wind he plants pine trees all around the orchard.

Here is a diagram of this situation where you can see the pattern of apple trees and pine trees for any number (n) of rows of apple trees :



Question 1

Aspect: Class 2; closed constructed response
PISA Scale Score = 557.
Complete the following table:

n	*Number of apple trees*	*Number of pine trees*
1	**1**	**8**
2	**4**	*16**
3	*9**	*24**
4	*16**	*32**
5	*25**	*40**

Percent Choosing Each Response	*Ireland*	*OECD*
Incorrect	46.8	35.6
Correct	43.2	49.8
Missing	0.7	2.0

* = correct response

Question 2

Aspect: Class 2; closed constructed response
PISA Scale Score = 665.
There are two formulae you can use to calculate the number of apple trees and the number of pine trees for the pattern described above.

Number of apple trees = n^2
Number of pine trees = $8n$
where *n* is the number of rows of apple trees.
There is a value of *n* for which the number of apple trees equals the number of pine trees.
Find the value of *n* and show your method of calculating this.

Percent Choosing Each Response	*Ireland*	*OECD*	*Key*
Incorrect	31.2	24.0	Other incorrect responses (e.g. n=0)
Correct	23.3	24.9	Responses with answer n=8 (various methods)
Missing	45.5	51.1	

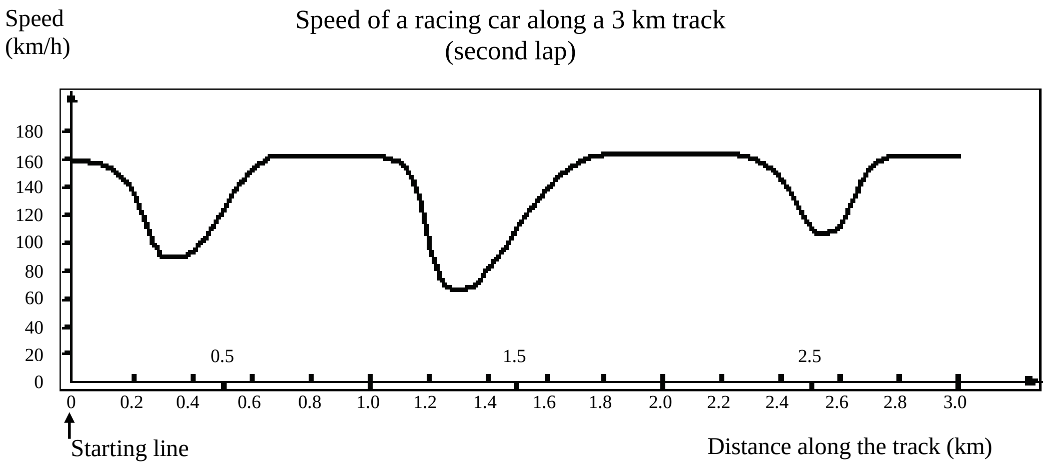
Question 3

Aspect: Class 3; open constructed response
PISA Scale Score = 732 (fully correct).
Suppose the farmer wants to make a much larger orchard with many rows of trees.
As the farmer makes the orchard bigger, which will increase more quickly the number of apple trees or the number of pine trees? Explain how you found your answer.

Percent Choosing Each Response	*Ireland*	*OECD*	*Key*
Incorrect	58.0	52.7	Correct response but insufficient; wrong explanation
Partially Correct	9.4	10.5	Correct response with specific examples; some evidence
Fully Correct	9.2	8.1	Correct response with valid explanation
Correct	13.8	28.7	
Missing	23.5	10.5	

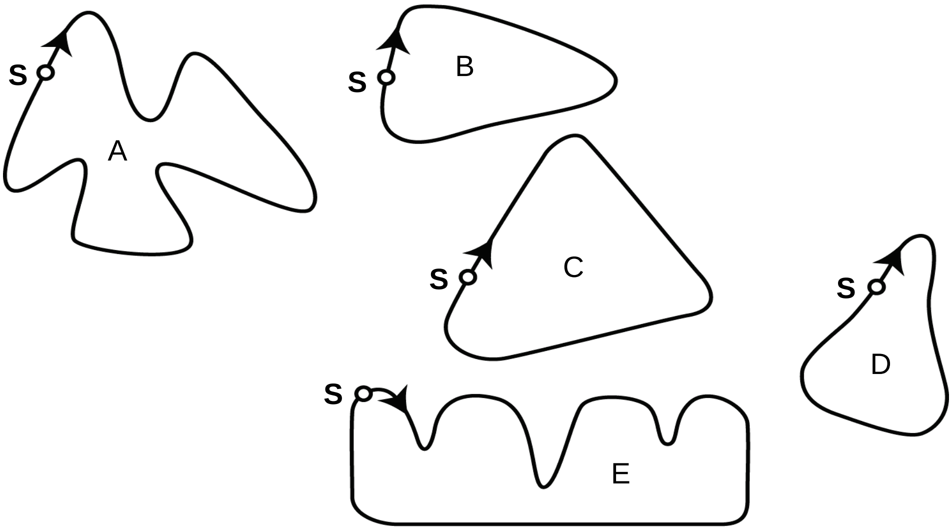
Unit: Speed of Racing Car
(Context: Personal; Big Idea: Growth and Change; Maths Strand: Functions)

This graph shows how the speed of a racing car varies along a flat (level) 3 kilometre track during its second lap.



Question 4

Aspect:Class 2; multiple choice
PISA Scale Score = 665.
Here are pictures of five tracks:
Along which one of these tracks was the car driven to produce the speed graph shown earlier?



S: Starting point

Percent Choosing Each Response		
	Ireland	*OECD*
A	20.9	16.9
B*	18.5	28.6
C	3.8	7.7
D	5.1	5.3
E	50.7	37.5
Missing	1.0	4.0

*=Key

Question 5

Aspect: Class 1; multiple choice

PISA Scale Score = 413.

Where was the lowest speed recorded during the second lap?

A at the starting line.

B at about 0.8 km.

C* at about 1.3 km.

D halfway around the track.

Percent Choosing Each Response		
	Ireland	*OECD*
A	7.2	5.6
B	2.4	2.8
C*	83.5	83.4
D	4.5	6.3
Missing	2.4	1.9

*=Key

Question 6

Aspect: Class 1; multiple choice

PISA Scale Score = 423.

What can you say about the speed of the car between the 2.6 km and 2.8 km marks?

A The speed of the car remains constant.

B* The speed of the car is increasing.

C The speed of the car is decreasing.

D The speed of the car cannot be determined from the graph.

Percent Choosing Each Response		
	Ireland	*OECD*
A	4.8	4.4
B*	81.4	82.7
C	8.2	7.4
D	4.7	3.9
Missing	0.9	1.7

*=Key

Question 7

Aspect: Class 2; multiple choice

PISA Scale Score = 502.

What is the approximate distance from the starting line to the beginning of the longest straight section of the track?

A 0.5 km

B* 1.5 km

C 2.3 km

D 2.6 km

Percent Choosing Each Response		
	Ireland	*OECD*
A	10.9	11.5
B*	66.0	66.9
C	11.6	10.7
D	9.9	7.7
Missing	1.6	3.2

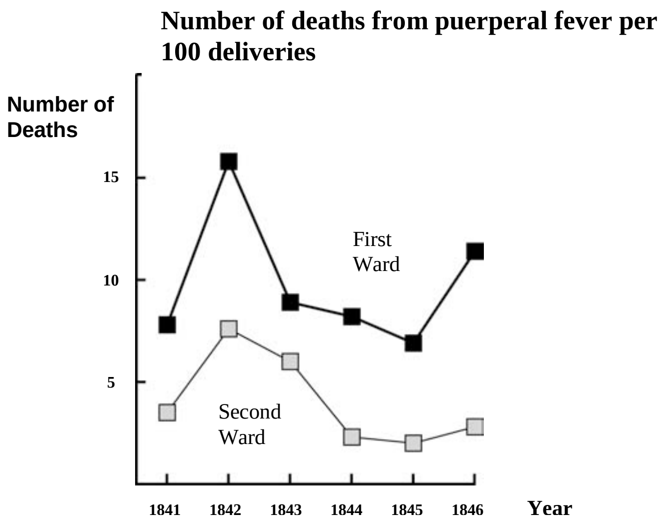
*=Key

Scientific Literacy

Unit: Semmelweis *(Context: Historical; Area: Life and Health; Topic: Biological Sciences)*

"July 1846. Next week I will take up a position as 'Herr Doktor' at the First Ward of the maternity clinic of the Vienna General Hospital. I was frightened when I heard about the percentage of patients who die in this clinic. This month not less than 36 of the 208 mothers died there, all from puerperal fever. Giving birth to a child is as dangerous as first-degree pneumonia."

These lines from the diary of Ignaz Semmelweis (1818-1865) illustrate the devastating effects of puerperal fever, a contagious disease that killed many women after childbirth. Semmelweis collected data about the number of deaths from puerperal fever in both the First and the Second Wards (see graph).



Graph

Physicians, among them Semmelweis, were completely in the dark about the cause of puerperal fever. Semmelweis continues:

"December 1846. Why do so many women die from this fever after giving birth without any problems? For centuries science has told us that it is an invisible epidemic that kills mothers. Causes may be changes in the air or some extraterrestrial influence or a movement of the earth itself, an earthquake."

Nowadays not many people would consider extraterrestrial influence or an earthquake as possible causes of fever. But in the time Semmelweis lived, many people, even scientists, did! We now know it has to do with hygienic conditions. Semmelweis knew that it was unlikely that fever could be caused by extraterrestrial influence or an earthquake. He pointed at the data he collected (see graph) and used these to try to persuade his colleagues.

Question 1

Aspect: Critically evaluating;. open constructed response

PISA Scale Score = 679 (fully correct). PISA Scale Score=651 (partially correct).

Suppose you were Semmelweis.

Give a reason (based on the data Semmelweis collected) why puerperal fever is unlikely to be caused by earthquakes.

Percent Choosing Each Response	*Ireland*	*OECD*	*Key*
Incorrect	51.0	43.5	Earthquakes do not cause fever; is another cause
Partially Correct	9.9	7.3	Earthquakes infrequent; effect people outside wards; not always associated with fever
Fully Correct	21.3	21.6	Refer to difference between number of deaths in the two wards
Correct	26.2	25.2	
Missing	17.8	27.7	

Question 2
(Part 2 of Text)

Part of the research in the hospital was dissection. The body of a deceased person was cut open to find the cause of death. Semmelweis recorded that the students working on the First ward usually took part in dissections on women who died the previous day, before they examined women who had just given birth. They did not pay much attention to cleaning themselves after the dissections. Some were even proud of the fact that you could tell by their smell that they had been working in the mortuary, as this showed how industrious they were!

One of Semmelweis' friends died after having cut himself during such a dissection. Dissection of his body showed he had the same symptoms as mothers who died from puerperal fever. This gave Semmelweis a new idea.

Aspect: Recognising questions;. multiple choice
PISA Scale Score = 506.
Semmelweis' new idea had to do with the high percentage of women dying
in the maternity wards and the students' behaviour.
What was this idea?

A* Having students clean themselves after dissections should lead to a decrease in puerperal fever.
B Students should not take part in dissections because they may cut themselves.
C Students smell because they do not clean themselves after a dissection.
D Students want to show that they are industrious, which makes them careless when they examine the women.

Percent Choosing Each Response		
	Ireland	*OECD*
A*	69.8	63.8
B	6.1	7.5
C	6.6	6.0
D	12.7	14.5
Missing	4.9	8.2

*=Key

Question 3

Semmelweis succeeded in his attempts to reduce the number of deaths due to puerperal fever. But puerperal fever even today remains a disease that is difficult to eliminate.

Fevers that are difficult to cure are still a problem in hospitals. Many routine measures serve to control this problem. Among these measures is washing sheets at high temperatures.

Aspect: Apply scientific knowledge; open constructed response
PISA Scale Score = 480.
Explain why high temperature (while washing sheets) helps to reduce the risk that patients will contract a fever.

Percent Choosing Each Response			
	Ireland	*OECD*	
Incorrect	17.1	13.9	Refers to killing the disease; other incorrect answer
Correct	69.8	67.6	Killing/removal of bacteria; microorganisms; sterilisation
Missing	13.1	18.5	

Question 4

Aspect: Apply scientific knowledge; multiple choice
PISA Scale Score = 521.

Nowadays, many diseases may be cured by using antibiotics.

However, the success of some antibiotics against puerperal fever has diminished in recent years. What is the reason for this?

A Once produced, antibiotics gradually lose their activity.

B* Bacteria become resistant to antibiotics.

C These antibiotics only help against puerperal fever, but not against other diseases.

D The need for these antibiotics has been reduced because public health conditions have improved considerably in recent years.

Percent Choosing Each Response		
	Ireland	*OECD*
A	6.5	6.0
B*	51.0	60.4
C	6.7	7.4
D	29.9	17.5
Missing	5.1	8.7

*=Key

Unit: Ozone *(Context: Global; Area: Earth/Environmental; Topic: Earth/Space Science)*

Read the following section of an article about the ozone layer.

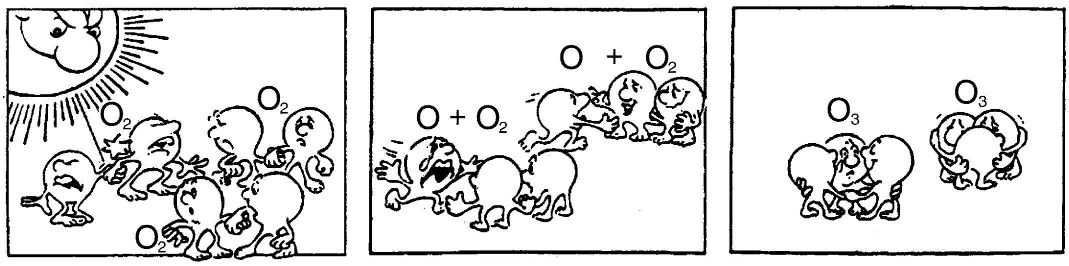
The atmosphere is an ocean of air and a precious natural resource for sustaining life on the Earth. Unfortunately, human activities based on national/personal interests are causing harm to this common resource, notably by depleting the fragile ozone layer, which acts as a protective shield for life on the Earth.

Ozone molecules consist of three oxygen atoms, as opposed to oxygen molecules which consist of two oxygen atoms. Ozone molecules are exceedingly rare: fewer than ten in every million molecules of air. However, for nearly a billion years, their presence in the atmosphere has played a vital role in safeguarding life on Earth. Depending on where it is located, ozone can either protect or harm life on Earth. The ozone in the troposphere (up to 10 kilometres above the Earth's surface) is 'bad' ozone which can damage lung tissues and plants. But about 90 percent of ozone found in the stratosphere (between 10 and 40 kilometres above the Earth's surface) is 'good' ozone which plays a beneficial role by absorbing dangerous ultraviolet (UV-B) radiation from the Sun.

Without this beneficial ozone layer, humans would be more susceptible to certain diseases due to the increased incidence of ultra-violet rays from the Sun. In the last decades the amount of ozone has decreased. In 1974 it was hypothesised that chlorofluorocarbons (CFCs) could be a cause for this. Until 1987, scientific assessment of the cause-effect relationship was not convincing enough to implicate CFCs. However, in September 1987, diplomats from around the world met in Montreal (Canada) and agreed to set sharp limits to the use of CFCs.

Question 5

Aspect: Communicating conclusions; open constructed response
PISA Scale Score = 695 (fully correct). PISA Scale Score = 641 (partially correct).
In the text (part 2 of text) above nothing is mentioned about the way ozone is formed in the atmosphere. In fact each day some ozone is formed and some other ozone disappears. The way ozone is formed is illustrated in the following comic strip.



Suppose you have an uncle who tries to understand the meaning of this strip. However, he did not get any science education at school and he doesn't understand what the author of the strip is explaining. He knows that there are no little creatures in the atmosphere but he wonders what those little creatures in the strip stand for, what those strange notations O, O_2 and O_3 mean and which processes the strip represents. He asks you to explain the strip. Assume that your uncle knows:

- that O is the symbol for oxygen;
- what atoms and molecules are.

Write an explanation of the comic strip for your uncle.
In your explanation, use the words atoms and molecules in the way they are used in lines 5 and 6.

Percent Choosing Each Response			
	Ireland	*OECD*	*Key*
Incorrect	26.9	35.9	Does not correctly mention any of the 3 aspects
Partially Correct	21.4	24.3	Answers with 1 or 2 of aspects
Fully Correct	18.0	11.4	3 aspects: 1. Splitting of oxygen molecules 2. By sunlight 3. Combine with others to form ozone
Correct	26.2	28.3	
Missing	33.7	28.4	

Question 6

Aspect: Apply knowledge; closed constructed response

PISA Scale Score = 655.

In terms of the article, is the ozone that is formed during thunderstorms 'bad ozone' or 'good ozone'? Choose the answer and the explanation that is supported by the text.

	Bad ozone or good ozone?	**Explanation**
A	Bad	It is formed during bad weather.
B*	Bad	It is formed in the troposphere.
C	Good	It is formed in the stratosphere.
D	Good	It smells good.

Percent Choosing Each Response

	Ireland	*OECD*
A	10.5	7.5
B*	39.0	35.4
C	22.0	22.6
D	2.2	1.7
Missing	26.4	22.8

*=Key

Question 7

Aspect: Apply knowledge. Science in life and health (physiological change)
PISA Scale Score = 560.
Lines 14 and 15 state: "Without this beneficial ozone layer, humans would be more susceptible to certain diseases due to the increased incidence of ultra-violet rays from the Sun." Name one of these specific diseases.

Percent Choosing Each Response

	Ireland	*OECD*	
Incorrect	37.4	32.6	Other responses
Correct	55.8	54.6	Skin cancer; Melanoma; Cataracts
Missing	6.8	12.8	

A1.2. Readability of PISA Texts

An analysis of the readability of materials used to assess literacy in PISA was conducted in Ireland. The purpose of the analysis was to establish whether the materials were at an appropriate level of difficulty for students. Most readability formulae currently in use include two variables: one accounting for the semantic factor and one for the syntactic factor. Flesch's Reading Ease formula (1948, discussed in Klare, 1984), is no exception, in that the two variables it uses to estimate readability are sentence length (syntax) and word length (semantics). The Flesch Reading Ease formula rates text on a 100-point scale; a high score denotes an easy text, while a low score signals a difficult text. A related measure, the Flesch-Kincaid Grade Level score, is based on the same two variables, but reports scores in terms of U.S. grade-school levels. For example, a score of 8.0 indicates that a text can be understood without difficulty by an average student at the beginning of eighth grade (second year at second level in Ireland). The maximum score on the scale is 12.0 (twelfth-grade, or the final year of second-level schooling).

The readability of the PISA assessment materials was analysed in three ways: texts only; texts and items combined; and items only. A limitation of the exercise was that it was not possible to include assessment texts or items that involved diagrams, timetables, photographs or graphs. Only texts and items that were at least 10 words in length were included. Complex multiple-choice items were excluded. Twenty-eight of 38 reading units, 14 of 16 mathematical literacy units, and 12 of 13 science units, including items accompanying texts, were analysed.

The reading ease scores for the reading literacy text units range from 38.5 to 87.7, while the grade-level estimates range from 3.7 to 12.0 (Table A1.1). The mean reading ease is moderate at 59.5, and the mean grade level is 8.8 (i.e., the eighth month of 8th grade, or the last term of second year, second level in Ireland). The reading ease and grade level values are similar when computed and averaged for texts and items combined, whilst analyses of items on their own yield a slightly higher mean reading ease score (65.7) and a slightly lower mean grade level (7.1; around first year level). Taken together, these outcomes suggest that the texts and items in the PISA reading literacy assessment are at an appropriate level of difficulty, and are close to the modal grade level of the target population (Grade 9 or third year). Fourteen percent of texts have a grade-level score below sixth grade (sixth class), indicating their suitability for at least some lower-achieving students.

The mean reading ease scores for the mathematical literacy texts are slightly higher than those for the reading literacy texts, indicating that the mathematical texts were less difficult to read, while the mean grade level is slightly lower. Values for items indicate that that they are easier than the texts. Over one-third (37.9%) of texts have a grade level lower than sixth grade, suggesting that a substantial portion of the material can be read by some students of lower reading ability, though it must be acknowledged that readability formulae may not be sensitive enough to the difficulty inherent in mathematical language and concepts. The complexity of graphics accompanying the mathematical literacy texts was not considered.

The mean reading ease score for scientific literacy texts (56.6) is lower than either reading literacy or mathematical literacy, indicating that the scientific literacy texts are more difficult, while the mean grade level (9.5) is higher. Values for items indicate that they are easier than the texts. Just over 12% of texts have a grade-level score lower than sixth grade. In contrast, over one-third have grade-level scores at tenth grade (fourth year at second level) or higher.

Table A1.1. Indices of Reading Ease and Grade Equivalent Scores for Texts Only, Items Only, and Texts and Items Combined, for Reading Literacy, Mathematical Literacy, and Scientific Literacy

Domain	*Text Only*		*Items Only*		*Text and Items*	
	Ease	*Grade*	*Ease*	*Grade*	*Ease*	*Grade*
Reading Literacy						
Mean (SD)	59.5 (14.1)	8.8 (2.5)	65.7 (17.1)	7.1 (2.8)	60.8 (13.1)	8.6 (2.4)
Range	38.5, 87.7	3.7, 12.0	23.2, 100	0.2, 12.0	37.9, 88.1	3.6,12.0
Mathematical Literacy						
Mean	61.8 (27.0)	7.7 (2.9)	69.2 (13.6)	6.8 (2.3)	66.8 (16.9)	7.3 (2.6)
Range	0.0, 83.9	3.7, 12.0	34.7, 87.9	2.4, 1.0	25.7, 84.8	4.0, 12.0
Scientific Literacy						
Mean	56.6 (13.0)	9.5 (2.3)	65.6 (15.2)	7.4 (2.6)	60.4 (11.0)	8.8 (2.0)
Range	42.5, 84.4	5.1, 12.0	29.0, 100	2.0, 12.0	42.4, 83.6	4.7, 12.0

Appendix 2

Note: There is no additional information corresponding to Chapter 2 (Achievement Outcomes and Correlates of Achievement in Previous International Assessments)

Appendix 3

Tables A3.1 and A3.2 give the mean betas (standard errors), *t*s and *p* values associated with the correlation coefficients and R^2s reported in Tables 3.11 and 3.12.

Table A3.1. Mean Coefficients, t Values, and p values for Correlations Among Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy, and for the Three Reading Literacy Subscales

	Mean Beta (SE)	*t**	*p*
Literacy Scales			
Reading – Mathematical	0.922 *(0.018)*	50.465	<.001
Reading – Scientific	0.926 *(0.015)*	62.516	<.001
Mathematical – Scientific	0.022 *(0.022)*	34.436	<.001
Reading Literacy Subscales			
Retrieve – Interpret	0.966 *(0.009)*	108.137	<.001
Retrieve – Reflect/Evaluate	1.006 *(0.010)*	103.761	<.001
Interpret – Reflect/Evaluate	1.000 *(0.014)*	71.685	<.001

*t = mean standardised beta divided by the standard error of the mean standardised beta; degrees of freedom = 80 (the number of variance strata associated with balanced repeated replicate (BRR) method of variance estimation).

Table A3.2. Mean Coefficients, t Values, and p values for Partial Correlations of Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy

	Mean Beta (SE)	*t**	*p*
Reading Literacy			
Mathematical Literacy	0.305 *(0.272)*	6.541	<.001
Scientific Literacy	0.738 *(0.723)*	18.193	<.001
Mathematical Literacy			
Reading Literacy	0.329 *(0.368)*	5.923	<.001
Scientific Literacy	0.426 *(0.468)*	7.266	<.001
Scientific Literacy			
Reading Literacy	0.610 *(0.622)*	17.441	<.001
Mathematical Literacy	0.327 *(0.298)*	8.105	<.001

*t = mean standardised beta divided by the standard error of the mean standardised beta; degrees of freedom = 80 (the number of variance strata associated with balanced repeated replicate (BRR) method of variance estimation).

Appendix 4

A4.1 Description of Variables Derived from PISA Student and School Questionnaires

Student Background Variables

- *Gender.* Whether the student is male or female. (Categorical)
- *Chronological Age.* The student's age in months. (Continuous)
- *Socioeconomic Status*
  - (i) Mother's SES, based on her main occupation, coded according to the International Standard Classification of Occupation System (ISCO) and scaled according to the International Socioeconomic Index (ISEI). An additional category, 'Homemaker' was also identified. (Continuous)
  - (ii) Father's SES, based on father's main occupation, coded and scaled using standard ISCO/ISEI procedures. (Continuous)
  - (iii) Parents' SES, based on highest main occupation of either the mother or father, coded and scaled using standard ISCO/ISEI procedures. (Continuous)
- *Parents' Education*
  - (iv) Mother's highest level of education, based on her highest level completed (No Education/Primary; Lower Secondary; Upper Secondary; Third Level). (Categorical)
  - (v) Father's highest level of education, coded as for mother's level. (Categorical)
  - (vi) Parents' highest level of education, coded for mother's level. (Categorical)
- *Family Structure:*
  - (i) Household structure: whether the student lives in a lone parent household or not. (Categorical)
  - (ii) Number of siblings. (Continuous)

Home Educational Climate Variables

- *Parental Engagement.* IRT-generated composite based on three items: frequency with which parents discussed politics or social issues; frequency with which parents discussed books, films or television programmes; and frequency of listening to classical music. (Continuous)
- *Home Educational Resources.* IRT-generated composite based on whether students owned or had access to each of the following at home: dictionary, quiet place to study, desk for studying, and textbooks. (Continuous)
- *Books in the Home.* Variable based on number of books in student's home along the following scale: 0-10, 11-50, 51-100, 101-250; and 251+. (Categorical) (The categories '0' and '1-10'; and '251-500' and '500+' in the original scale were collapsed, giving five categories instead of the original seven.)

Student as Learner Variables

- *Academic Orientation.* Variable based on students' responses as to whether (i) they intended to remain in school after the Junior Certificate examination; (ii) do the Leaving Certificate; and (iii) attend a third-level college or university after finishing second-level schooling. Students who responded positively to all three questions were regarded as having a high academic orientation. (Categorical)
- *Dropout Risk.* Variable based on students' responses to questions which tap reasons for their intent to drop out of school after the Junior

Certificate. Students who responded positively to these questions were classified as having a high risk of dropping out. (Categorical)

- *Learning Support – English.* Variable based on whether or not the student had attended learning support (remedial) classes in English in the three years prior to PISA assessment. (Categorical)
- *Absence from School.* Variable based on the number of days on which the student was absent from school during the two weeks prior to the assessment, using a 3-point scale (0 days, 1-2 days, 3 or more days). (Categorical)
- *Homework and Study*
  - (i) Time spent on homework/study in a typical school week, including weekends, in each of three subjects (English, mathematics, science), using a 4-point scale (no time, less than an hour, 1-3 hours, more than 3 hours). (Categorical)
  - (ii) Frequency with which homework was completed on time across all subjects, using a 4-point scale (never, sometimes, most times, always). (Categorical)
- *Study of Science.* Variable indicating whether or not student studied science in preparation for the Junior Certificate Examination. (Categorical)
- *Current Grade Level.* Variable indicating student's current grade level (second year/grade 8, third year/grade 9, fourth year (Transition)/grade 10, fifth year/grade 11). (Categorical)
- *Level of Subjects Studied.* Variable indicating the level(s) at which the student studied English, mathematics and science in preparation for the Junior Certificate Examination. (Categorical)
- *Use of Calculators in PISA.* Whether or not the student used a calculator in the PISA assessment. (Categorical)
- *Learning Strategies and Processes*. Set of 54 items divided into 12 IRT-generated composite scales. The scales are:

  (i) Control strategies (N items = 5; 4-point scale ranging from almost never to always) Includes statement such as

  'When I study, I start by figuring out what exactly I need to learn'

  'When I study, I make sure that I remember the most important things'

  (ii) Effort and persistence (N items = 4; 4-point scale ranging from almost never to always) Includes statement such as

  'When studying, I work as hard as possible'

  'When studying, I keep working even if the material is difficult'

  (iii) Memorising (N items = 4; 4-point scale ranging from almost never to always) Includes statements such as

  'When I study, I try to memorise everything that might be covered'

  'When I study, I practice by saying the material to myself over and over'

  (iv) Self-efficacy (N items = 4; 4-point scale ranging from almost never to always) Includes statement such as

  'I'm certain I can understand the most difficult material presented in readings'

  'I'm certain I can master the skills being taught'

  (v) Control expectation (N items = 4; 4-point scale ranging from almost never to always) Includes statement such as

  'When I sit myself down to learn something really hard, I can learn it'

  'If I decide not to get any bad grades, I can really do it'

  (vi) Elaboration (N items = 4; 4-point scale ranging from almost never to always) Includes statements such as

'When I study, I figure out how the information might be useful in the real world'

'When I study, I try to relate new material to things I have learned in other subjects'

(vii) Instrumental motivation (N items = 9; 4-point scale ranging from almost never to always) Includes statements such as

'I study to increase my job opportunities'

'When I do math, I sometimes get totally absorbed'

'I read in my spare time'

(viii) Competitive learning (N items = 4; 4-point scale ranging from disagree to agree) Includes statements such as

'I like to try to be better than other students'

'I would like to be the best at something'

(ix) Co-operative learning (N items = 5; 4-point scale ranging from disagree to agree) Includes statements such as

'I like to work with other students'

'It is helpful to put together everyone's ideas when working on a project'

(x) Self-concept academic (N items = 3; 4-point scale ranging from disagree to agree) Includes statements such as

'I learn quickly in most school subjects'

'I'm good at most school subjects'

(xi) Self-concept verbal (N items = 3; 4-point scale ranging from disagree to agree) Includes statements such as

'I'm hopeless in English classes'

'I get good marks in English'

(xii) Self-concept in mathematics (N items = 3; 4-point scale ranging from disagree to agree) Includes statements such as

'I get good marks in mathematics'

'Mathematics is one of my best subjects'

Reading Habits and Attitudes towards Reading

- *Reading Diversity.* IRT-generated composite based on the frequencies with which students read 6 types of text (magazines, comic books, fiction books, non-fiction books, e-mails and web pages, and newspapers). (Continuous)
- *Borrowing Library Books.* Variable indicating frequency of borrowing library books from a public library or from the school library, according to a four-point scale (hardly ever or never, a few times a year, about once a month, several times a month). (Categorical)
- *Frequency of Leisure Reading.* Frequency of leisure reading reported by students (never/hardly ever, few times a year, once a month, several times a month). (Categorical)
- *Attitude Towards Reading.* IRT-generated composite based on 9 statements designed to elicit attitude towards reading (e.g., 'I find it hard to finish books'; 'I enjoy going to a bookshop or a library') to which students selected a response ranging from 'strongly disagree' to 'strongly agree'. A composite, based on students' scores across the 9 statements, and taking into account whether statements were positively or negatively worded, was formed. (Continuous)

School Structure

- *School Sector*. A variable classifying schools according to whether they were in the secondary, vocational or community/comprehensive sector. (Categorical)
- *Management and Funding.* Based on the responses of principal teachers to questions about the proportions of school funding obtained from government

sources, student fees, donations/funds raised by parents, and whether their school was managed by a publicly accountable body. Schools were categorised according to whether they were private government independent, private government funded, or public government funded. (Categorical)

- *Disadvantaged Status.* Using the Department of Education and Science's post-primary schools database, schools were categorised according to whether or not they were in the Department's Disadvantaged Area Schools Scheme. (Categorical)
- *Gender Composition.* Using the Department of Education's post-primary schools database, schools were categorised according to the gender of the 15-year olds served by the school as all boys, all girls, or co-educational. (Categorical)

School Climate/Policy

- *Disciplinary Climate*. IRT-generated composite combining students' responses to a series of statements about disciplinary climate in English classes, each of which called for a response on a 4-point scale (never, some lessons, most lessons, every lesson). (Continuous)
- *Student Behaviour.* IRT-generated composite summarising responses by principal teachers regarding the frequency with which students engaged in six behaviour-related activities (e.g., disrupting classes, bullying other students). (Continuous)
- *School Autonomy.* IRT-generated composite summarising principal teachers' responses to questions asking whether or not each of 12 activities (e.g., formulating the school budget) was a responsibility of the school. (Continuous)
- *Calculator Use in Mathematics Classes.* Frequency of calculator usage in mathematics classes by third year students (never, occasionally, frequently, always), as reported by school principals. (Categorical variable)

School Resources

- *Student-Teacher Ratio*. Variable computed by dividing school size (the number of students in a school) by the number of full- and part-time teachers, where full-time teachers received a weighting of 1.0, and part-time teachers a weighting of 0.5. (Continuous)
- *Class Size.* Variables based on the number of students in a student's English, mathematics and science classes, reported by students. (Continuous)
- *Computer-Student Ratio.* Variable computed by dividing the number of computers available to 15-year olds in a school by the number of 15-year olds in the school. (Continuous)

A4.2 Mapping the Irish Education System onto the International Standard Classification of Education (ISCED)

The *International Standard Classification of Education* (ISCED)(OECD,1999b) is used by the OECD in classifying the levels and types of education of OECD countries to allow comparisons between countries' education systems may be made. The levels are as follows:

ISCED Level 1: primary education.
ISCED Level 2: lower second-level education.
ISCED Level 3: upper second-level education.
ISCED Level 4: programmes which may be considered post-Level 3 but pre-tertiary.
ISCED Level 5: tertiary education.
There are three sub-divisions at each of Levels 2 and 3.

- Level 2A comprises programmes designed to prepare students for direct access to Level 3 in a sequence which would ultimately lead to tertiary education. The Junior Certificate Programme is categorised as this level.
- Level 2B comprises programmes designed to prepare students for direct access to programmes at Level 3C. There are no Irish programmes classified as Level 2B.
- Level 2C programmes are designed primarily for direct access to the labour market at the end of Level 2 (lower secondary level). There are no Irish programmes classified as Level 2C.
- Level 3A comprises programmes designed to provide direct access to primarily academically oriented tertiary programmes. It corresponds to the Leaving Certificate and Leaving Certificate Vocational Programmes.
- Level 3B programmes are designed to provide direct access to technically- or vocationally-oriented tertiary programmes. There are no Irish programmes classified as Level 3B.
- Level 3C programmes lead directly to labour market or to post-primary non-tertiary programmes. The Transition Year and Leaving Certificate Applied Programmes are classified as Level 3C, though it must be acknowledged that many students who complete the Transition Year proceed to tertiary education.

A4.3 Procedure for Computing Estimates and Standard Errors

As computer packages such as WesVar do not provide standard errors associated with some parameters, such as the percentage of students at each proficiency level, it was necessary to compute such standard errors using the following procedure.

1. Separate estimates for groups of students (e.g., females, males) were computed in WesVar for each plausible value. Hence, five parameters were estimated (one associated with each plausible value). Each set (P1 to P5) was then averaged to provide a mean parameter estimate (MP). Standard errors (SE1 to SE5) were generated in WesVar for each parameter estimate (P1 to P5).
2. The beween- and within-imputation variance for each mean parameter estimate (MP) was computed. The between-imputation variance for each parameter estimate was computed using the following formula:

$$[(MP\text{-}P1)^2 + (MP\text{-}P2)^2 + (MP\text{-}P3)^2 + (MP\text{-}P4)^2 + (MP\text{-}P5)^2]/4$$

The within-imputation variance was computed using the following formula:

$$[(SE1^2 + SE2^2 + SE3^2 + SE4^2 + SE5^2)]/5$$

The total imputation variance was computed by summing the between- and within-imputation variances. In doing so, a weight of 1.2 (1 + 1/M, where M is the number of plausible values) was applied to the between-imputation variance. The square root of the total variance provided an estimate of the standard error of the parameter estimate.

A4.4 Procedure for Testing Differences between Mean Achievement Scores and Proportions

The approach used to test the significance of differences between mean achievement scores associated with different levels of an explanatory variable involved the following steps:

1. Using the Bonferroni procedure (Dunn, 1961), two-tailed alphas associated with the desired 95% and 90% confidence intervals (i.e., .05 and .10) were divided by the number of comparisons to be made, and the critical values of *t* associated with these adjusted alphas were identified in a statistical table of such values, using 80 degrees of freedom (the number of variance strata associated with balanced repeated

replicate (BRR) method of variance estimation). When two comparisons are made, the adjusted alphas are .025 (.05/2) and .05 (.10/2). For three comparisons, the adjusted alphas are .017 (.05/3) and .033 (.10/3), and so forth.

2. After identifying an appropriate reference category (e.g., female; medium socioeconomic status), the differences between each mean and mean of the reference category, and the corresponding standard errors of the difference were computed. The standard error of the difference was computed using the formula

$$SE_{diff} = \sqrt{SE_1^{\ 2} + SE_2^{\ 2}} \qquad (SE_{diff} = \text{Standard Error of the Difference})$$

where SE_1 and SE_2 are the standard errors of the two means to be compared.

3. 95% and 90% confidence intervals were constructed by adding to and subtracting from each mean difference the product of the corresponding standard error of the difference and the relevant adjusted critical value.

It can be concluded that a difference between a pair of means is not significant if zero falls in the confidence interval around the mean difference. In some cases, a difference which is not significant at the .05 level may be significant at the .10 level. A similar procedure was used to test the significance of differences between proportions. A note on the interpretation of significant differences may be found in Inset 5.3 in Chapter 5.

A4.5 Procedure for Computing Correlation Coefficients

Pearson correlation coefficients (*r*) were obtained using the square roots of the coefficients of determination (R^2) associated with each of the five linear regressions computed between the explanatory variable and the response variable (which has five plausible values). Since the distribution of resulting *r*s are not asymptotically normally distributed (they are bounded by +/- 1), each was transformed to a *z*-score using Fisher's transformation (see Schafer, 1997), and the average of the five *z*-scores was then back-transformed to yield a coefficient of correlation. The following formulas were used for transformation and backtransformation:

Transformation: *Fisher's z = ½ log((1+R)/(1-R))*

Back-transformation: *r = (Exp(2*meanz) - 1)/(EXP(2*meanz) + 1)*

where *meanz* is the mean of the five z-scores.

A4.6 Procedure for Calculating Critical Values for Correlation Coefficients

According to Agresti and Finlay (1997), the hypothesis that the population $r = 0$ can be tested using the sample value of *r*, and is equivalent to the *t* test for the hypothesis that $\beta = 0$, where β is the slope of the least square line. While Agresti and Finlay present this in the context of ordinary-least-squares regression with independent observations, it was extended in the current study to complex samples. Since the regression coefficients associated with complex samples and their standard errors can be calculated using software such as Wesvar, the significance of *r* was inferred by computing the *t* statistic (i.e., by dividing the mean β by its standard error), as this also provides a test of linear association in the population. The corresponding *p* value was obtained from a table of critical values of *t*, using 80 degrees of freedom (the number of strata in the BRR method of variance estimation).

A4.7 Additional Tables

Table A4.1. Student Performance on the Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scales, by Gender

	Combined Reading Literacy						Mathematical Literacy						Scientific Literacy					
	Male		Female		Difference		Male		Female		Difference		Male		Female		Difference	
Country	Mean	(SE)	Mean	(SE)	Diff	(SE)	Mean	(SE)	Mean	(SE)	Diff	(SE)	Mean	(SE)	Mean	(SE)	Diff	(SE)
Finland	520.1	(3.00)	571.4	(2.78)	**–51**	(2.63)	536.7	(2.83)	535.7	(2.62)	1	(3.34)	534.5	(3.51)	541.0	(2.70)	–6	(3.83)
Canada	518.9	(1.76)	551.1	(1.70)	**–32**	(1.63)	538.8	(1.76)	528.6	(1.59)	**10**	(1.90)	529.1	(1.91)	531.0	(1.74)	–2	(1.88)
New Zealand	506.8	(4.18)	552.6	(3.80)	**–46**	(6.28)	536.4	(5.03)	539.1	(4.14)	–3	(6.73)	522.9	(4.62)	534.8	(3.80)	**–12**	(7.00)
Australia	512.7	(4.04)	546.3	(4.74)	**–34**	(5.44)	539.3	(4.12)	527.3	(5.15)	12	(6.19)	526.4	(3.91)	528.9	(4.78)	–3	(5.29)
Ireland	512.8	(4.18)	541.5	(3.55)	**–29**	(4.56)	510.1	(4.02)	497.3	(3.42)	**13**	(5.14)	510.7	(4.23)	516.9	(4.17)	–6	(5.52)
Korea Rep. of	518.5	(3.77)	532.7	(3.70)	**–14**	(6.02)	558.6	(4.59)	532.1	(5.09)	**27**	(7.83)	560.7	(4.34)	541.3	(5.13)	**19**	(7.64)
UK	511.6	(3.03)	537.2	(3.45)	**–26**	(4.28)	534.3	(3.49)	526.2	(3.67)	8	(5.00)	535.0	(3.44)	531.4	(3.98)	4	(5.20)
Japan	507.3	(6.74)	536.9	(5.39)	**–30**	(6.44)	560.7	(7.29)	552.6	(5.92)	8	(7.43)	546.7	(7.18)	554.1	(5.89)	–7	(7.20)
Sweden	498.6	(2.56)	535.6	(2.48)	**–37**	(2.70)	514.2	(3.24)	506.7	(3.02)	7	(3.99)	512.2	(3.49)	512.6	(2.87)	0	(3.92)
Austria	494.7	(3.23)	520.3	(3.59)	**–26**	(5.24)	530.1	(3.98)	503.0	(3.66)	**27**	(5.92)	525.7	(3.79)	513.9	(4.27)	**12**	(6.25)
Belgium	492.4	(4.24)	525.2	(4.92)	**–33**	(5.99)	523.7	(4.65)	517.5	(5.18)	6	(6.08)	495.9	(5.24)	498.0	(5.61)	–2	(6.68)
Iceland	488.5	(2.12)	528.1	(2.14)	**–40**	(3.11)	513.5	(3.09)	518.0	(2.90)	–5	(4.00)	494.8	(3.44)	499.5	(3.01)	–5	(4.73)
Norway	485.6	(3.79)	528.8	(2.86)	**–43**	(4.04)	505.9	(3.79)	495.4	(2.93)	**11**	(3.98)	498.8	(4.07)	505.4	(3.25)	–7	(4.95)
France	490.3	(3.50)	519.1	(2.72)	**–29**	(3.38)	524.8	(4.07)	510.7	(2.80)	**14**	(4.16)	504.1	(4.24)	498.1	(3.77)	6	(4.80)
USA	489.7	(8.41)	518.2	(6.20)	**–29**	(4.12)	496.8	(8.85)	489.6	(7.33)	7	(5.42)	497.0	(8.93)	501.8	(6.49)	–5	(5.31)
Denmark	485.4	(2.95)	510.3	(2.87)	**–25**	(3.28)	522.1	(3.14)	507.3	(3.04)	**15**	(3.71)	487.6	(3.91)	475.9	(3.54)	**12**	(4.76)
Switzerland	480.1	(4.85)	510.0	(4.50)	**–30**	(4.17)	537.0	(5.31)	522.8	(4.82)	**14**	(4.97)	499.7	(5.69)	492.7	(4.65)	7	(5.38)
Spain	481.2	(3.35)	505.4	(2.76)	**–24**	(3.17)	486.8	(4.26)	468.6	(3.30)	**18**	(4.50)	492.1	(3.49)	491.4	(3.58)	1	(4.01)
Czech Rep.	472.6	(4.11)	510.1	(2.53)	**–37**	(4.71)	503.8	(4.40)	492.1	(2.96)	**12**	(5.15)	511.9	(3.83)	511.4	(3.20)	1	(5.07)
Italy	469.2	(5.14)	507.4	(3.57)	**–38**	(7.05)	462.1	(5.32)	453.7	(3.75)	8	(7.28)	473.6	(5.62)	482.6	(3.90)	–9	(7.73)
Germany	467.6	(3.17)	502.2	(3.88)	**–35**	(5.21)	497.6	(3.12)	483.0	(3.99)	**15**	(5.12)	489.2	(3.38)	486.7	(3.43)	3	(4.73)
Hungary	464.5	(5.34)	496.2	(4.35)	**–32**	(5.73)	491.7	(5.22)	484.7	(4.91)	7	(6.15)	495.7	(5.79)	497.3	(5.02)	–2	(6.90)
Poland	461.4	(5.99)	497.5	(5.52)	**–36**	(6.97)	472.5	(7.48)	467.7	(6.30)	5	(8.55)	486.1	(6.10)	480.0	(6.50)	6	(7.37)
Greece	455.7	(6.07)	492.7	(4.63)	**–37**	(5.01)	450.8	(7.71)	444.3	(5.44)	7	(7.37)	457.0	(6.08)	464.4	(5.16)	–7	(5.75)
Portugal	457.7	(4.98)	482.4	(4.64)	**–25**	(3.77)	464.3	(4.66)	445.8	(4.74)	**19**	(4.90)	456.2	(4.81)	462.5	(4.24)	–6	(4.35)
Luxembourg	428.8	(2.58)	455.7	(2.30)	**–27**	(3.77)	454.1	(2.97)	439.2	(3.20)	**15**	(4.73)	441.0	(3.58)	447.5	(3.25)	–7	(4.99)
Mexico	411.5	(4.18)	431.8	(3.84)	**–20**	(4.34)	392.7	(4.49)	382.0	(3.84)	11	(4.88)	423.3	(4.20)	419.0	(3.85)	4	(4.82)
OECD Country Avg	484.7	(2.31)	513.6	(1.97)	–29	(1.61)	503.5	(2.57)	492.5	(2.27)	11	(2.30)	502.5	(2.51)	502.7	(2.01)	0	(2.02)

Note. Positive differences indicate that males perform better; negative differences indicate that females perform better. Statistically significant differences indicated in bold.

Table A4.2. Student Performance on the Retrieve, Interpret and Reflect/Evaluate Reading Subscales, by Gender

	Retrieving Information						*Interpreting Texts*						*Reflection and Evaluation*					
	Male		*Female*		*Difference*		*Male*		*Female*		*Difference*		*Male*		*Female*		*Difference*	
Country	*Mean*	*(SE)*	*Mean*	*(SE)*	*Diff*	*(SE)*	*Mean*	*(SE)*	*Mean*	*(SE)*	*Diff*	*(SE)*	*Mean*	*(SE)*	*Mean*	*(SE)*	*Diff*	*(SE)*
Finland	533.7	*(3.43)*	577.9	*(3.07)*	**–44**	*(3.45)*	528.6	*(3.31)*	579.4	*(3.19)*	**–51**	*(3.10)*	500.8	*(2.97)*	563.7	*(3.08)*	**–63**	*(2.81)*
Canada	518.5	*(1.92)*	543.2	*(1.84)*	**–25**	*(1.79)*	517.9	*(1.81)*	546.8	*(1.69)*	**–29**	*(1.62)*	520.8	*(1.77)*	565.7	*(1.71)*	**–45**	*(1.66)*
New Zealand	516.2	*(4.70)*	555.0	*(4.14)*	**–39**	*(7.10)*	505.8	*(4.27)*	548.9	*(3.94)*	**–43**	*(6.58)*	501.9	*(4.17)*	558.9	*(3.88)*	**–57**	*(6.40)*
Australia	522.6	*(4.32)*	551.0	*(4.95)*	**–28**	*(5.74)*	511.1	*(4.08)*	544.7	*(4.86)*	**–34**	*(5.68)*	506.8	*(3.96)*	548.4	*(4.69)*	**–42**	*(5.55)*
Ireland	513.6	*(4.24)*	536.0	*(3.63)*	**–22**	*(4.68)*	513.4	*(4.34)*	540.5	*(3.61)*	**–27**	*(4.74)*	515.1	*(3.99)*	552.3	*(3.31)*	**–37**	*(4.30)*
Korea Rep. of	526.9	*(4.10)*	532.9	*(4.29)*	–6	*(6.88)*	520.8	*(3.67)*	529.6	*(3.65)*	–9	*(5.87)*	514.1	*(3.72)*	541.2	*(3.53)*	**–27**	*(5.81)*
UK	514.6	*(3.13)*	534.0	*(3.43)*	**–19**	*(4.41)*	503.4	*(2.95)*	526.9	*(3.49)*	**–24**	*(4.28)*	522.1	*(3.02)*	557.2	*(3.45)*	**–35**	*(4.39)*
Japan	512.5	*(7.00)*	539.3	*(5.78)*	**–27**	*(6.82)*	505.3	*(6.35)*	530.5	*(5.27)*	**–25**	*(6.10)*	508.2	*(7.22)*	550.6	*(5.53)*	**–42**	*(7.04)*
Sweden	501.5	*(2.72)*	531.5	*(2.94)*	**–30**	*(3.21)*	505.2	*(2.49)*	539.7	*(2.49)*	**–34**	*(2.85)*	485.7	*(2.66)*	536.4	*(2.47)*	**–51**	*(2.64)*
Austria	494.5	*(3.27)*	510.4	*(3.64)*	**–16**	*(5.38)*	497.2	*(3.13)*	519.9	*(3.80)*	**–23**	*(5.32)*	492.6	*(3.46)*	531.9	*(3.77)*	**–39**	*(5.48)*
Belgium	503.8	*(4.74)*	528.9	*(5.44)*	**–25**	*(6.65)*	497.8	*(3.93)*	528.9	*(4.69)*	**–31**	*(6.08)*	475.3	*(5.25)*	521.8	*(5.30)*	**–47**	*(6.36)*
Iceland	485.4	*(2.36)*	517.3	*(2.21)*	**–32**	*(3.31)*	496.6	*(2.13)*	534.5	*(2.08)*	**–38**	*(2.99)*	475.7	*(1.97)*	529.4	*(1.90)*	**–54**	*(2.84)*
Norway	490.1	*(3.91)*	522.6	*(2.90)*	**–32**	*(3.99)*	486.6	*(3.71)*	527.1	*(2.75)*	**–40**	*(3.83)*	478.6	*(3.95)*	538.5	*(2.94)*	**–60**	*(4.10)*
France	503.4	*(3.83)*	526.6	*(3.03)*	**–23**	*(3.62)*	492.1	*(3.46)*	519.0	*(2.73)*	**–27**	*(3.30)*	476.5	*(3.72)*	515.4	*(2.89)*	**–39**	*(3.88)*
USA	485.7	*(8.79)*	511.7	*(6.52)*	**–26**	*(4.47)*	490.9	*(8.38)*	517.9	*(6.37)*	**–27**	*(4.18)*	488.1	*(8.45)*	524.1	*(6.30)*	**–36**	*(4.48)*
Denmark	491.4	*(3.40)*	505.8	*(3.21)*	**–14**	*(3.50)*	484.7	*(3.08)*	505.8	*(2.88)*	**–21**	*(3.36)*	480.1	*(3.17)*	523.1	*(3.30)*	**–43**	*(3.64)*
Switzerland	487.2	*(5.19)*	509.7	*(4.68)*	**–22**	*(4.67)*	483.5	*(4.81)*	509.7	*(4.38)*	**–26**	*(4.17)*	465.4	*(5.35)*	511.5	*(5.09)*	**–46**	*(4.54)*
Spain	476.7	*(3.74)*	492.6	*(3.13)*	**–16**	*(3.81)*	481.0	*(3.34)*	502.4	*(2.79)*	**–21**	*(3.44)*	486.8	*(3.48)*	525.6	*(2.94)*	**–39**	*(3.47)*
Czech Rep.	467.4	*(4.72)*	494.8	*(2.81)*	**–27**	*(5.43)*	483.0	*(4.05)*	517.4	*(2.58)*	**–34**	*(4.63)*	457.2	*(4.29)*	511.2	*(2.59)*	**–54**	*(4.66)*
Italy	473.7	*(5.65)*	504.2	*(4.04)*	**–31**	*(7.85)*	470.5	*(4.61)*	509.1	*(3.29)*	**–39**	*(6.39)*	460.0	*(5.48)*	507.3	*(3.80)*	**–47**	*(7.59)*
Germany	471.3	*(3.00)*	496.9	*(3.98)*	**–26**	*(5.20)*	472.0	*(2.86)*	505.0	*(3.84)*	**–33**	*(4.80)*	455.4	*(3.53)*	503.3	*(4.19)*	**–48**	*(5.49)*
Hungary	465.4	*(6.03)*	490.9	*(4.80)*	**–25**	*(6.35)*	466.4	*(5.06)*	494.5	*(4.13)*	**–28**	*(5.43)*	459.7	*(5.66)*	502.9	*(4.47)*	**–43**	*(5.83)*
Poland	461.3	*(6.61)*	489.3	*(6.18)*	**–28**	*(7.76)*	465.4	*(5.53)*	500.0	*(5.45)*	**–35**	*(6.61)*	451.3	*(6.45)*	503.9	*(5.81)*	**–53**	*(7.38)*
Greece	434.5	*(6.74)*	466.5	*(4.97)*	**–32**	*(5.55)*	459.2	*(5.49)*	492.0	*(4.25)*	**–33**	*(4.59)*	468.2	*(6.76)*	522.1	*(5.42)*	**–54**	*(6.10)*
Portugal	447.2	*(5.50)*	463.5	*(4.98)*	**–16**	*(4.23)*	460.7	*(4.75)*	484.6	*(4.28)*	**–24**	*(3.47)*	461.3	*(5.06)*	497.0	*(4.47)*	**–36**	*(3.81)*
Luxembourg	423.9	*(2.59)*	444.3	*(2.51)*	**–20**	*(3.96)*	433.1	*(2.63)*	460.0	*(2.32)*	**–27**	*(3.91)*	423.2	*(2.98)*	463.6	*(2.82)*	**–40**	*(4.51)*
Mexico	395.8	*(5.02)*	407.7	*(4.36)*	–12	*(5.11)*	409.9	*(3.77)*	427.0	*(3.33)*	**–17**	*(3.89)*	427.9	*(4.87)*	462.8	*(4.54)*	**–35**	*(5.59)*
OECD Country Avg	484.9	(2.44)	508.1	(2.10)	–23	(1.81)	485.4	(2.29)	511.8	(1.99)	–26	(1.62)	483.0	(2.29)	523.1	(2.01)	–40	(1.79)

Note. Positive differences indicate that males perform better; negative differences indicate that females perform better. Statistically significant differences indicated in bold.

Table A4.3. Percentages of Irish Students at Each Proficiency Level on the Retrieving Information Subscale, and Percentage Differences, by Gender

	Males			*Females*			*All Available*		
Level	*N*	*Percent*	*SE*	*N*	*Percent*	*SE*	*N*	*Percent*	*SE*
<1	89	4.8	0.66	62	3.1	0.60	150	4.0	0.48
1	192	10.4	1.02	134	6.7	0.71	326	8.6	0.67
2	376	20.4	1.37	317	16.0	1.18	693	18.2	0.91
3	510	27.7	1.42	565	28.4	1.22	1075	28.1	1.04
4	427	23.2	1.24	568	28.6	1.16	996	25.9	0.86
5	247	13.4	1.14	342	17.2	1.20	589	15.3	0.85

Mean Percent Differences (Reference Category: Female)

	Difference	*SED*	*BCI95%*		*BCI90%*	
<1	1.7	0.89	–0.7	4.1	–0.4	3.8
1	3.7	1.24	**0.4**	**7.0**	**0.7**	**6.7**
2	4.5	1.81	–0.3	9.3	**0.1**	**8.8**
3	–0.7	1.88	–5.7	4.2	–5.2	3.8
4	–5.4	1.69	**–9.9**	**–0.9**	**–9.4**	**–1.3**
5	–3.8	1.65	–8.1	0.6	–7.7	0.2

Note. Information on gender was not available for 25 students. Hence, the percentages in this table are based on a sample of 3829 students (1841 males and 1988 females). SED = Standard Error of the difference; BCI95% = Bonferroni–adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A4.4. Percentages of Irish Students at Each Proficiency Level on the Interpreting Information Subscale, and Percentage Differences, by Gender

	Males			*Females*			*All Available*		
Level	*N*	*Percent*	*SE*	*N*	*Percent*	*SE*	*N*	*Percent*	*SE*
<1	80	4.3	0.68	53	2.7	0.79	133	3.4	0.49
1	181	9.8	0.93	136	6.9	1.03	317	8.1	0.69
2	393	21.4	1.16	313	15.8	1.65	706	18.2	0.90
3	526	28.6	1.13	574	28.9	1.68	1100	28.8	1.13
4	433	23.5	1.42	564	28.4	1.97	997	26.2	1.10
5	228	12.4	1.30	349	17.5	1.63	577	15.3	1.00

Mean Percent Differences (Reference Category: Female)

	Difference	*SED*	*BCI95%*		*BCI90%*	
<1	1.7	1.05	–1.1	4.4	–0.8	4.2
1	3.0	1.39	–0.7	6.7	–0.3	6.3
2	5.6	2.02	**0.3**	**10.9**	**0.8**	**10.5**
3	–0.3	2.02	–5.7	5.0	–5.2	4.5
4	–4.8	2.43	–11.2	1.6	–10.7	1.0
5	–5.2	2.09	–10.7	0.4	**–10.2**	**–0.1**

Note. Information on gender was not available for 25 students. Hence, the percentages in this table are based on a sample of 3829 students (1841 males and 1988 females). SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A4.5. Percentages of Irish Students at Each Proficiency Level on the Reflect/Evaluate Subscale, and Percentage Differences, by Gender

	Males			*Females*			*All Available*		
Level	*N*	*Percent*	*SE*	*N*	*Percent*	*SE*	*N*	*Percent*	*SE*
<1	63	3.4	0.59	24	1.2	0.36	87	2.3	0.38
1	181	9.8	0.93	87	4.4	0.71	268	6.5	0.75
2	384	20.9	1.33	251	12.6	1.09	635	16.7	0.97
3	579	31.5	1.32	580	29.2	1.34	1160	30.3	0.95
4	473	25.7	1.47	665	33.5	1.42	1138	29.6	1.03
5	183	10.0	1.16	380	19.1	1.13	564	14.6	0.86

Table A4.5. Continued

Mean Percent Differences (Reference Category: Female)	*Difference*	*SED*	*BCI95%*		*BCI90%*	
<1	2.2	0.69	**0.4**	**4.0**	**0.5**	**3.8**
1	5.5	1.17	**2.4**	**8.6**	**2.7**	**8.3**
2	8.3	1.72	**3.7**	**12.8**	**4.2**	**12.3**
3	2.3	1.88	–2.7	7.2	–2.2	6.71
4	–7.8	2.04	**–13.2**	**–2.4**	**–12.6**	**–3.0**
5	–9.2	1.62	**–13.4**	**–4.9**	**–13.0**	**–5.3**

Note. Information on gender was not available for 25 students. Hence, the percentages in this table are based on a sample of 3829 students (1841 males and 1988 females). SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A.4.6. Mean Reading Literacy Scores of Irish Students, and Mean Score Differences, by Lone Parent Status and Student Gender

	Males			*Females*			*All*		
	%	*Mean*	*SE*	*%*	*Mean*	*SE*	*%*	*Mean*	*SE*
Yes	13.3	496.5	7.66	12.4	515.8	8.47	12.8	505.9	6.09
No	86.7	515.4	4.26	87.6	545.2	3.45	87.2	530.5	3.23
All	100.0	512.9	4.14	100.0	541.5	3.56	100.0	527.4	3.18

Mean Score Differences (Reference Category: Female)	*Diff*	*SED*	*BCI95%*		*BCI90%*	
Myes-FYes	–19.4	11.42	–45.5	6.7	–42.1	3.3
MNo-FNo	–29.8	5.49	**–42.3**	**–17.2**	**–40.7**	**–18.9**

Note. Information on gender and lone parent status was unavailable for 33 students who completed the PISA reading literacy assessment. Hence the percentages in this table are based on a sample of 3821 students (1834 males and 1987 females). Diff= difference between means; SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A.4.7. Mean Mathematical Literacy Scores of Irish Students, and Mean Score Differences, by Lone Parent Status and Student Gender

	Males			*Females*			*All*		
	%	*Mean*	*SE*	*%*	*Mean*	*SE*	*%*	*Mean*	*SE*
Yes	13.9	493.3	9.45	13.0	467.5	8.93	13.4	480.5	6.38
No	86.1	513.1	4.07	87.0	501.6	3.38	86.6	507.2	2.80
All	100.0	510.4	3.97	100.0	497.2	3.42	100.0	503.6	2.70

Mean Score Differences (Reference Category: Female)	*Diff*	*SED*	*BCI95%*		*BCI90%*	
MYes-FYes	25.9	13.00	–3.8	55.6	**0.0**	**51.7**
MNo-FNo	11.5	5.29	–0.6	23.6	**0.9**	**22.0**

Note. Information on gender and lone parent status was unavailable for 21 students who completed the PISA mathematical literacy assessment. Hence the percentages in this table are based on a sample of 2107 students (1003 males and 1104 females). Diff= difference between means; SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A.4.8. Mean Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Lone Parent Status and Student Gender

	Males			*Females*			*All*		
	%T	*Mean*	*SE*	*%T*	*Mean*	*SE*	*%T*	*Mean*	*SE*
Yes	13.6	498.6	9.58	13.2	488.8	8.35	13.4	493.7	6.84
No	86.4	512.6	4.46	86.8	521.2	4.28	86.6	516.9	3.36
All	100.0	510.7	4.25	100.0	516.9	4.17	100.0	513.8	3.19

Mean Score Differences (Reference Category: Female)

	Diff	*SED*	*BCI95%*		*BCI90%*	
MYes-FYes	9.8	12.70	–19.3	38.8	–15.5	35.0
MNo-FNo	–8.6	6.18	–20.9	3.7	–18.9	1.7

Note. Information on gender and lone parent status was unavailable for 17 students who completed the PISA assessment of scientific literacy. Hence the percentages in this table are based on a sample of 2117 students (1019 males and 1098 females). Diff= difference between means; SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A.4.9. Mean Reading Literacy Scores of Irish Students, and Mean Score Differences, by Index of Books in the Home and Gender

	Males			*Females*			*All*		
	%	*Mean*	*SE*	*%*	*Mean*	*SE*	*%*	*Mean*	*SE*
None	1.6	457.9	16.46	1.2	437.3	19.25	1.4	449.1	13.50
1 to 10	8.6	465.3	9.50	8.0	482.2	9.02	8.3	473.5	7.06
11 to 50	23.3	490.0	5.85	20.8	508.5	5.75	22.0	498.8	4.00
51 to 100	20.9	509.4	6.49	21.8	534.1	4.84	21.3	522.2	4.07
101 to 250	21.6	529.0	6.15	23.4	559.4	4.49	22.5	545.0	4.11
251 to 500	14.2	549.4	6.28	14.7	581.6	5.96	14.4	566.0	4.65
>500	9.7	546.9	8.98	10.2	585.2	8.63	10.0	566.8	6.62
All	100.0	513.8	4.13	100.0	541.7	3.54	100.0	527.9	3.17

Mean Score Differences (Reference Category: Female)

	Diff	*SED*	*BCI95%*		*BCI90%*	
MNone – Fnone	20.6	25.32	–49.3	90.5	–42.8	84.0
M1-10 - F1-10	–17.0	13.10	–53.1	19.2	–49.8	15.8
M11-50 - F11-50	–18.5	8.20	–41.1	4.1	–39.0	2.0
M51-100 - F51-100	–24.7	8.09	**–47.1**	**–2.4**	**–45.0**	**–4.5**
M101-250 – F101-250	–30.4	7.61	**–51.4**	**–9.4**	**–49.5**	**–11.4**
M251-500 – F251-500	–32.2	8.66	**–56.1**	**–8.3**	**–53.9**	**–10.5**
M>500 - F>500	–38.3	12.45	**–72.7**	**–3.9**	**–69.5**	**–7.1**

Note. Information on gender and books in the home was unavailable for 49 students who completed the PISA reading literacy assessment. Hence the percentages in this table are based on a sample of 3829 students (1821 males and 1984 females). Diff = difference between means; SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval. Correlation coefficients for females r = .371; df=80; p<.001; for males r = .281; df=8; p<.001.

Table A.4.10. Mean Mathematical Literacy Scores of Irish Students, and Mean Score Differences, by Index of Books in the Home and Gender

	Males			*Females*			*All*		
	%	*Mean*	*SE*	*%*	*Mean*	*SE*	*%*	*Mean*	*SE*
None	1.6	459.1	22.59	1.2	427.2	21.22	1.4	445.3	17.27
1 to 10	10.2	473.7	9.09	7.0	445.4	10.67	8.6	461.8	7.07
11 to 50	22.2	485.2	7.51	20.0	467.0	6.88	21.1	476.4	5.18
51 to 100	21.8	505.8	6.78	24.4	493.7	5.76	23.1	499.3	4.20
101 to 250	21.2	527.9	5.78	23.2	506.5	5.77	22.3	516.5	4.19
251 to 500	14.2	546.3	6.70	14.1	538.5	6.19	14.2	542.3	4.59
>500	8.8	544.9	11.92	10.1	533.6	9.05	9.5	538.7	8.09
All	100.0	511.1	3.90	100.0	497.5	3.41	100.0	504.2	2.68

Mean Score Differences (Reference Category: Female)

	Diff	*SED*	*BCI95%*		*BCI90%*	
MNone – Fnone	31.9	30.99	–53.7	117.5	–45.7	109.5
M1-10 - F1-10	28.3	14.02	–10.4	67.0	–6.8	63.5
M11-50 - F11-50	18.3	10.18	–9.9	46.4	–7.2	43.8
M51-100 - F51-100	12.1	8.89	–12.4	36.7	–10.2	34.4
M101-250 - F101-250	21.4	8.17	–1.1	44.0	**0.9**	**41.9**
M251-500 - F251-500	7.8	9.12	–17.4	33.0	–15.1	30.6
M>500 - F>500	11.3	14.96	–30.0	52.6	–26.2	48.8

Note. Information on gender and books in the home was unavailable for 30 students who completed the PISA mathematical literacy assessment. Hence the percentages in this table are based on a sample of 2098 students (996 males and 1102 females). Diff = difference between means; SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A.4.11. Mean Scientific Literacy Scores of Irish Students, and Mean Score Differences, by Index of Books in the Home and Gender

	Males			*Females*			*All*		
	%T	*Mean*	*SE*	*%T*	*Mean*	*SE*	*%T*	*Mean*	*SE*
None	2.0	463.8	18.86	1.1	418.2	21.14	1.6	447.4	15.64
0 to 10	8.6	463.5	10.61	7.7	453.3	11.34	8.1	458.6	8.32
11 to 50	24.0	489.3	6.55	21.0	482.7	6.88	22.5	486.2	4.59
51 to 100	20.5	510.5	7.68	22.3	510.1	6.28	21.4	510.3	4.71
101 to 250	21.1	524.3	7.91	23.1	540.3	6.37	22.1	532.7	5.02
251 to 500	14.3	551.7	7.98	14.1	551.6	8.42	14.2	551.7	5.66
>500	9.5	535.7	10.90	10.8	557.4	10.82	10.1	547.4	7.98
All	100.0	511.6	4.22	100.0	516.9	4.18	100.0	514.3	3.17

Mean Score Differences (Reference Category: Female)

	Diff	*SED*	*BCI95%*		*BCI90%*	
MNone – Fnone	45.7	28.33	–32.5	123.9	–25.3	116.6
M1-10 - F1-10	10.2	15.53	–32.6	53.1	–28.7	49.1
M11-50 - F11-50	6.6	9.50	–19.6	32.8	–17.2	30.4
M51-100 - F51-100	0.3	9.92	–27.1	27.7	–24.5	25.2
M101-250 - F101-250	–16.1	10.15	–44.1	12.0	–41.5	9.4
M251-500 - F251-500	0.1	11.60	–31.9	32.1	–29.0	29.2
M>500 - F>500	–21.7	15.36	–64.1	20.7	–60.1	16.8

Note. Information on gender and books in the home was unavailable for 26 students who completed the PISA assessment of scientific literacy. Hence the percentages in this table are based on a sample of 2108 students (1011 males and 1097 females). Diff = difference between means; SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Table A4.12. Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores, by Selected Learning Strategies and Processes

	Combined Reading Literacy				*Mathematical Literacy*				*Scientific Literacy*			
	%T	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*	*%T*	*%A*	*Mean*	*SE*
Control Strategies												
High	32.6	33.3	548.7	3.34	33.3	34.0	517.6	3.62	32.4	33.1	529.9	4.67
Med	32.9	33.6	532.4	4.09	32.1	32.8	508.2	3.90	33.2	33.9	521.1	4.59
Low	32.5	33.1	504.0	4.18	32.5	33.2	488.2	4.13	32.3	33.0	493.8	3.94
Missing	2.0	0.0	440.2	11.44	2.1	0.0	416.3	12.46	2.1	0.0	435.4	15.26
All	98.0	100.0	526.7	3.24	97.9	100.0	502.9	2.72	97.9	100.0	513.4	3.18
Self-Efficacy												
High	33.0	33.6	550.1	4.51	32.5	33.2	529.1	4.29	32.9	33.6	539.1	5.01
Med	33.8	34.4	528.7	3.53	34.5	35.2	502.5	3.33	33.9	34.6	511.8	3.76
Low	31.3	31.9	505.1	4.45	30.9	31.6	481.7	4.11	31.2	31.8	492.8	4.53
Missing	2.0	0.0	443.3	11.82	2.1	0.0	416.3	12.46	2.0	0.0	437.8	15.45
All	98.0	100.0	526.7	3.24	97.9	100.0	502.9	2.72	98.0	100.0	513.4	3.18
Control Expectations												
High	30.0	30.6	557.0	3.91	30.6	31.2	527.1	4.09	28.6	29.2	538.2	5.04
Med	38.2	38.9	526.9	3.84	37.9	38.7	504.8	3.51	39.5	40.3	515.8	3.95
Low	29.9	30.5	501.3	4.13	29.5	30.1	481.2	3.96	29.9	30.5	491.3	4.24
Missing	1.9	0.0	442.4	11.84	2.0	0.0	416.8	12.43	2.0	0.0	438.4	15.61
All	98.1	100.0	526.7	3.24	98.0	100.0	502.9	2.72	98.0	100.0	513.4	3.18
Self-Concept (Academic)												
High	33.78	34.4	555.0	4.33	34.0	34.7	523.4	4.28	33.3	33.8	542.3	5.18
Med	37.5	38.2	530.4	3.34	37.1	37.7	510.0	3.52	37.9	38.6	516.7	3.51
Low	27.0	27.5	493.2	4.53	27.2	27.6	475.0	4.20	27.1	27.6	480.0	4.74
Missing	1.7	0.0	412.8	11.73	1.8	0.0	388.9	13.68	1.7	0.0	406.4	16.75
All	98.3	100.0	526.7	3.24	98.2	100.0	502.9	2.72	98.3	100.0	513.4	3.18
Self-Concept (Mathematics)												
High					33.6	34.3	528.3	4.00				
Med					34.3	35.0	498.2	3.67				
Low					30.0	30.6	486.9	3.23				
Missing					2.2	0.0	405.4	12.32				
All					97.8	100.0	502.9	2.72				

Table A4.13. Mean Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores of Irish Students, and Mean Score Differences, of Selected Learning Strategies and Processes

	Reading Literacy						*Mathematical Literacy*						*Scientific Literacy*					
	Diff	*SED*	*BCI95%*		*BCI90%*		*Diff*	*SED*	*BCI95%*		*BCI90%*		*Diff*	*SED*	*BCI95%*		*BCI90%*	
Control Strategies																		
Low-Med	–28.4	5.85	**–42.7**	**–14.0**	**–41.0**	**–15.7**	–19.9	5.68	**–33.8**	**–6.0**	**–32.2**	**–7.6**	–27.4	6.05	**–42.2**	**–12.6**	**–40.5**	**–14.3**
High-Med	16.3	5.28	**3.4**	**29.2**	**4.8**	**27.7**	9.4	5.32	–3.6	22.4	–2.2	20.9	8.8	6.55	–7.2	24.8	–5.4	23.0
Missing-Med	–92.2	12.15	**–121.8**	**–62.5**	**–118.4**	**–65.9**	–91.9	13.06	**–123.8**	**–60.0**	**–120.2**	**–63.6**	–85.7	15.94	**–124.7**	**–46.8**	**–120.2**	**–51.2**
Self-Efficacy																		
Low-Med	–23.5	5.68	**–37.4**	**–9.6**	**–35.8**	**–11.2**	–20.7	5.29	**–33.7**	**–7.8**	**–32.2**	**–9.3**	–19.0	5.89	**–33.4**	**–4.6**	**–31.8**	**–6.3**
High-Med	21.4	5.73	**7.4**	**35.4**	**9.0**	**33.8**	26.6	5.43	**13.3**	**39.9**	**14.8**	**38.3**	27.3	6.26	**12.0**	**42.6**	**13.7**	**40.8**
Missing-Med	–85.3	12.33	**–115.5**	**–55.2**	**–112.0**	**–58.6**	–86.2	12.90	**–117.7**	**–54.6**	**–114.1**	**–58.3**	–74.0	15.90	**–112.9**	**–35.1**	**–108.4**	**–39.6**
Control Expectations																		
Low-Med	–25.5	5.64	**–39.3**	**–11.8**	**–37.7**	**–13.3**	–23.7	5.29	**–36.6**	**–10.7**	**–35.1**	**–12.2**	–24.6	5.80	**–38.8**	**–10.4**	**–37.1**	**–12.0**
High-Med	30.1	5.48	**16.7**	**43.5**	**18.2**	**41.9**	22.3	5.39	**9.1**	**35.5**	**10.6**	**34.0**	22.4	6.40	**6.7**	**38.1**	**8.5**	**36.3**
Missing-Med	–84.5	12.45	**–114.9**	**–54.0**	**–111.4**	**–57.5**	–88.0	12.92	**–119.6**	**–56.4**	**–116.0**	**–60.1**	–77.4	16.10	**–116.8**	**–38.0**	**–112.3**	**–42.5**
Self-Concept (Academic)																		
Low-Med	–37.2	5.63	**–51.0**	**–23.5**	**–49.4**	**–25.1**	–35.0	5.48	**–48.4**	**–21.6**	**–46.8**	**–23.1**	–36.7	5.90	**–51.1**	**–22.2**	**–49.4**	**–23.9**
High-Med	24.6	5.47	**11.2**	**38.0**	**12.8**	**36.5**	13.4	5.54	–0.1	26.9	**1.4**	**25.4**	25.6	6.26	**10.3**	**40.9**	**12.1**	**39.1**
Missing-Med	–117.6	12.2	**–147.4**	**–87.8**	**–144.0**	**–91.2**	–121.0	14.13	**–155.6**	**–86.5**	**–151.6**	**–90.5**	–110.2	17.11	**–152.1**	**–68.4**	**–147.3**	**–73.2**
Self-Concept (Mathematics)																		
Low-Med							–11.4	4.89	**–23.3**	**0.6**	**–21.9**	**–0.8**						
High-Med							30.1	5.43	**16.8**	**43.3**	**18.3**	**41.8**						
Missing-Med							–92.8	12.85	**–124.2**	**–61.4**	**–120.6**	**–65.0**						

Note. SED = Standard Error of the difference; BCI95% = Bonferroni-adjusted 95% confidence interval; BCI90% = Bonferroni-adjusted 90% confidence interval.

Appendix 5

Table A5.1. Candidate Variables for Hierarchical Linear Models of Reading, Mathematical, and Scientific Literacy (Variable Type, Label, and Reference Category, Where Applicable)

Variable (Level)	*Description*	*Reading Literacy*	*Maths Literacy*	*Science Literacy*
Level 1 (Student)				
Gender (Male)	Binary (Male, Female); Reference category: Female	✓	✓	✓
Socio–economic status (SES)	Continuous Range: 18 (Min) to 88 (Max)	✓	✓	✓
Parents' Education (Par Ed)	Categorical (4): Primary; Lower Secondary; Upper Secondary; Third Level; Reference category: Upper Secondary	✓	✓	✓
Lone Parent (Sing Par)	Binary (Yes, No); Reference category: Yes	✓	✓	✓
Number of Siblings (No. Siblings)	Continuous: 0–11; Mode: 2	✓	✓	✓
Parental Engagement (Par. Engage)	Continuous: OECD Mean = 0.0; SD = 1.00	✓	✓	✓
Number of Books in the Home (Log Books in Home)	Log of Books in the Home	✓	✓	✓
Dropout Risk	Binary (High, Low); Reference category: Low	✓	✓	✓
Absence from School (Absence)	Categorical: 0 Absences (No absences in two weeks prior to PISA); 1–2 Absences; 3+ Absences; Reference category: 1–2 Absences	✓	✓	✓
Completion of Homework on Time (Homework)	Categorical: No homework (Homework never done on time); Some (Sometimes done on Time); Mostly (Mostly done on time); Always (Always done on time); Reference Category: Sometimes	✓	✓	✓
Grade	Categorical: Second Year; Third Year; Transition Year, Fifth Year); Reference category: Transition Year	✓	✓	✓
Diversity of Reading	Continuous: OECD Mean = 0.0; SD = 1.00	✓		
Frequency of Reading for Enjoyment (Freq Reading)	Categorical: none = no reading; < 30 = fewer than 30 minutes per day; 30–60 = 30–60 minutes per day; 60+ = more than 60 minutes	✓		
Attitude Towards Reading (Attitude)	Continuous: OECD Mean = 0.0; SD = 1.00	✓		
Studies Science in School	Binary (Yes, No); Reference category: Yes			✓
Level 2 (School)				
School Size/Stratum	Categorical: Large (81+ 15–year olds); Medium (41–80); Small: 17–40); Reference category: Medium	✓	✓	✓
School Sector	Categorical: Secondary, Community/ Comprehensive, Vocational; Reference category: Vocational	✓	✓	✓
Disadvantaged Status	Categorical (Yes/No); Reference category: Yes	✓	✓	✓
Gender Composition	Categorical: All boys; All girls; Mixed. Reference category: Mixed	✓	✓	✓
Negative disciplinary Climate	Continuous: OECD Mean = 0.0; SD = 1.00	✓	✓	✓
Student–Teacher Ratio	Continuous (total enrolment divided by number of teachers); Mean = 15.1; SD = 1.82	✓	✓	✓

Note. A tick indicates that the variable was included in the initial model of student achievement in a particular PISA domain.

Table A5.2. Alternative Final Model of Reading Literacy Achievement, With Attitude to Reading Removed

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	460.724	15.215			
Student-Level Variables					
Gender: Male–Female	37.504	11.836			
Socioeconomic Status	–0.280	0.432			
Socioeconomic Status Squared	0.011	0.004	t = 2.490	884	.013
Number of Siblings	3.347	2.778			
Number of Siblings Squared	–1.198	0.445	t = –2.689	456	.008
Log (Books Index)	53.666	5.716			
Log (Books Index) × Gender	–27.923	7.470	t = –3.738	337	<.001
Dropout Risk: Yes–No	–58.364	4.067	t = –14.350	138	<.001
Absence			Ddiff = 14.228	2	.001
No days–1 or 2 days	3.164	2.884			
Three days or more–1 or 2 days	–13.086	4.885			
Homework on Time			Ddiff = 25.341	3	<.001
Never–Sometimes	–16.279	6.430			
Mostly–Sometimes	–11.459	3.091			
Always–Sometimes	3.406	3.149			
Grade Level			Ddiff = 275.768	3	<.001
Grade 8–Grade 10	–97.949	8.248			
Grade 9–Grade 10	–34.614	3.396			
Grade 11–Grade 10	–1.722	4.205			
Freq. of Leisure Reading			Ddiff = 122.845	3	<.001
No Time–Up to 30 mins	–21.410	3.160			
30–60 mins–Up to 30 mins	11.368	3.681			
>60 mins–Up to 30 mins	12.401	4.102			
School-Level Variables					
Disciplinary Climate	–12.660	5.020	t = –2.522	134	.012
School Type			Ddiff = 23.916	2	<.001
Secondary–Comm, Comp	2.224	5.506			
Vocational–Comm, Comp	–20.607	6.546			
Designated disadv–Not designated disadv	22.750	4.324	t = 5.261	134	<.001
Variance Components					
Level 2 Random Effects					
Intercept Variance	207.176				
Dropout			Ddiff = 6.381	2	.041
Dropout Risk Variance	187.004				
Dropout Risk–Intercept Cov	136.225				
Level 1 Variance	4697.367				
Variables Dropped from Model (In Sequence)					
Parental Education	School Gender Composition				
Diversity of Reading	School Size				
Lone Parent Status	Non-missing × Student-Teacher Ratio				
Parental Engagement	Non-missing indicator for Student-Teacher Ratio				
Attitude to Reading x Gender					

Table A5.3. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Socioeconomic Status

Level of SES	*Input Value*	*Parameter Estimate*	*Products and Sum*
Low SES	30.3	–0.178	–5.39
Low SES squared	918.09	0.009	8.358
			2.968
Medium SES	47	–0.178	–8.361
Medium SES squared	2209	0.009	20.111
			11.749
High SES	64	–0.178	–11.386
High SES squared	4096	0.009	37.299
			25.904

Table A5.4. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Number of Siblings

Number of Siblings	*Input Value*	*Parameter Estimate*	*Products and Sum*
Siblings: None	0	3.623	0
	0	–1.212	0
			0
Siblings: 2	2	3.623	7.247
	4	–1.212	–4.848
			2.399
Siblings: 4	4	3.623	14.493
	16	–1.212	–19.134
			–4.900
Siblings: 6	6	3.623	21.74
	36	–1.212	–43.636
			–21.900
Siblings: 8	8	3.623	28.986
	64	–1.212	–77.574
			–48.588

Table A5.5. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Attitude to Reading

Level of Attitude	*Input Value*	*Parameter Estimate*	*Products and Sum*
Negative Attitude	–1.062	28.935	–30.718
Negative Attitude Squared	1.127	1.937	2.184
			–28.534
Average Attitude	–0.074	28.935	–2.133
Average Attitude Squared	0.005	1.937	0.011
			–2.122
Positive Attitude	1.057	28.935	30.596
Positive Attitude Squared	1.118	1.937	2.166
			32.762

Table A5.6. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Disciplinary Climate

Level of Climate	*Input Value*	*Parameter Estimate*	*Products*
Low Negative Climate	–1.213	–11.682	14.17
Medium Negative Climate	0.026	–11.682	–0.30
High Negative Climate	1.172	–11.682	–13.69

Table A5.7. Estimated Contributions to Scores in Reading Literacy Achievement Attributable to Books in the Home, by Gender

	Males			*Females*		
	Input Value	*Parameter Estimate*	*Products and Sum*	*Input Value*	*Parameter Estimate*	*Products and Sum*
Male	1	32.165	32.165	0	32.165	0
Log (books)	0	39.523	0	0	39.523	0
Male × Log (books)	0	–19.246	0	0	–19.246	0
			32.165			*0*
1–10 books (2)						
Male	1	32.165	32.165	0	32.165	0
Log (books)	0.693	39.523	27.39	0.693	39.523	27.390
Male × Log (books)	0.693	–19.246	–13.338	0	–19.246	0
			46.217			*27.390*
11–50 books (3)						
Male	1	32.165	32.165	0	32.165	0
Log (books)	1.099	39.523	43.436	1.099	39.523	43.436
Male × Log (books)	1.099	–19.246	–21.152	0	–19.246	0
			54.449			*43.436*
51–100 books (4)						
Male	1	32.165	32.165	0	32.165	0
Log (books)	1.386	39.523	54.779	1.099	39.523	43.436
Male × Log (books)	1.386	–19.246	–26.675	0	–19.246	0
			60.269			*43.436*
101–250 books (5)						
Male	1	32.165	32.165	0	32.165	0
Log (books)	1.609	39.523	63.593	1.609	39.523	63.593
Male × Log (books)	1.609	–19.246	–30.967	0	–19.246	0
			64.791			*63.593*
251–500 books (6)						
Male	1	32.165	32.165	0	32.165	0
Log (books)	1.792	39.523	70.826	1.792	39.523	70.826
Male × Log (books)	1.792	–19.246	–34.489	0	–19.246	0
			68.501			*70.826*
500+ books (7)						
Male	1	32.165	32.165	0	32.165	0
Log (books)	1.946	39.523	76.912	1.946	39.523	76.912
Male × Log (books)	1.946	–19.246	–37.453	0	–19.246	0
			71.624			*76.912*

Note. The log of books corresponds to the log of the value associated with the interval; for example; 101–250 books takes a value of 5, and log (5) = 1.792.

Table A5.8. Alternative Final Model of Mathematical Literacy Achievement Without Gender × Lone Parent Interaction

	Parameter	*SE*	*Test Statistic*	*df*	*p*
Intercept	424.948	12.046			
Student-Level Variables					
Gender	26.207	3.778	t = 6.936	73	<.001
SES	0.655	0.139	t = 4.723	35	<.001
Parental Education			Ddiff = 13.983	3	.003
None/Primary-Upper Sec	–13.727	5.830			
Lower Sec-Upper Sec	–14.031	4.619			
Third Level-Upper Sec	–4.001	4.314			
Dual parent-Lone parent	–8.654	4.969	t = –1.741	157	.081
Number of Siblings	–3.636	1.367	t = –2.659	29	.013
Log (Books)	47.761	5.053	t = 9.453	661	<.001
Dropout Risk	–53.662	4.931	t = –10.882	646	<.001
Homework on Time			Ddiff = 27.532	3	<.001
Never-Sometimes	–7.227	7.661			
Mostly-Sometimes	–13.052	3.934			
Always-Sometimes	10.166	4.015			
Grade Level			Ddiff = 134.319	3	<.001
Grade 8-Grade 10	–80.320	11.633			
Grade 9-Grade 10	–31.585	4.728			
Grade 11-Grade 10	–0.458	6.025			
School-Level Variables					
School Type			Ddiff = 10.639	2	.005
Secondary-Comm, Comp	5.149	5.510			
Vocational-Comm, Comp	–9.854	6.681			
Designated disadv-Not designated disadv	12.538	4.527	t = 2.770	135	.006
Variance Components					
Level 2 Variance	114.390		χ^2 = 191.983	135	.001
Level 1 Variance	4246.448				
Variables Dropped from Model (In Sequence)	School Gender Composition				
Absenteeism	Non-missing × Student-Teacher Ratio				
Parental Engagement	Non-Missing Indicator for Student-Teacher Ratio				
School Size	Disciplinary Climate				
Gender × Log (Books Index)	Male × Lone Parent				
Gender × Homework on Time					

Table A5.9. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Socioeconomic Status

Level of Climate	*Input Value*	*Parameter Estimate*	*Products*
Low SES	30.49	0.658	20.06
Medium SES	47.88	0.658	30.84
High SES	63.40	0.658	41.71

Table A5.10. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Number of Siblings

Number of Siblings	*Input Value*	*Parameter Estimate*	*Products*
Siblings: None	0	–3.610	0
Siblings: 2	2	–3.610	–7.22
Siblings: 4	4	–3.610	–14.44
Siblings: 6	6	–3.610	–21.66
Siblings: 8	8	–3.610	–28.88

Table A5.11. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Books in the Home

	Input Value	*Parameter Estimate*	*Products*
No Books (1)	0	47.987	0
1-10 books (2)	0.693	47.987	37.26
11-50 books (3)	1.097	47.987	52.72
51-100 books (4)	1.386	47.987	66.52
101-250 books (5)	1.609	47.987	77.23
251-500 books (6)	1.792	47.987	85.98
500+ books (7)	1.946	47.987	93.38

Note. The log of books corresponds to the log of the value associated with the interval; for example; 101–250 books takes a value of 5, and log (5) = 1.792.

Table A5.12. Estimated Contributions to Scores in Mathematical Literacy Achievement Attributable to Lone Parent Status, by Gender

	Males			*Females*		
	Input Value	*Parameter Estimate*	*Products and Sum*	*Input Value*	*Parameter Estimate*	*Products and Sum*
Lone Parent						
Male	1	23.943	23.943	0	23.943	0
Lone Parent	1	–18.034	–18.034	1	–18.034	–18.034
Male × Lone Par	1	18.682	18.682	0	18.682	0
			24.591			*–18.034*
Not Lone Parent						
Male	1	23.943	23.943	0	23.943	0
Lone Parent	0	–18.034	0	0	–18.034	0
Male × Lone Par	0	18.682	0	0	18.682	0
			23.943			*0*

Table A5.13. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Socioeconomic Status

Level of Climate	*Input Value*	*Parameter Estimate*	*Products*
Low SES	29.94	0.679	20.33
Medium SES	47.09	0.679	31.97
High SES	63.84	0.679	43.33

Table A5.14. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Number of Siblings

Number of Siblings	*Input Value*	*Parameter Estimate*	*Products*
Siblings: None	0	–4.943	0
Siblings: 2	2	–4.943	–9.89
Siblings: 4	4	–4.943	–19.77
Siblings: 6	6	–4.943	–29.66
Siblings: 8	8	–4.943	–39.54

Table A5.15. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Parental Engagement

Level of Engagement	*Input Value*	*Parameter Estimate*	*Products*
Low Engagement	–1.193	5.207	–6.21
Medium Engagement	–0.108	5.207	–0.56
High Engagement	0.797	5.207	4.15

Table A5.16. Estimated Contributions to Scores in Scientific Literacy Achievement Attributable to Books in the Home, by Gender

	Males			*Females*		
	Input Value	*Parameter Estimate*	*Products and Sun*	*Input Value*	*Parameter Estimate*	*Products and Sum*
Male	1	59.438	59.438	0	59.438	0
Log (books)	0	62.690	0	0	62.690	0
Male × Log (books)	0	–33.304	0	0	–33.304	0
			59.438			*0*
1–10 books (2)						
Male	1	59.438	59.438	0	59.438	0
Log (books)	0.693	62.690	43.453	0.693	62.690	43.453
Male × Log (books)	0.693	–33.304	–29.084	0	–33.304	0
			79.807			*43.453*
11–50 books (3)						
Male	1	59.438	59.438	0	59.438	0
Log (books)	1.099	62.690	68.872	1.099	62.690	68.872
Male × Log (books)	1.099	–33.304	–36.588	0	–33.304	0
			91.722			*68.872*
51–100 books (4)						
Male	1	59.438	59.438	0	59.438	0
Log (books)	1.386	62.690	86.906	1.099	62.690	86.906
Male × Log (books)	1.386	–33.304	–46.169	0	–33.304	0
			100.176			*86.906*
101–250 books (5)						
Male	1	59.438	59.438	0	59.438	0
Log (books)	1.609	62.690	100.895	1.609	62.690	100.895
Male × Log (books)	1.609	–33.304	–53.600	0	–33.304	0
			106.733			*100.895*
251–500 books (6)						
Male	1	59.438	59.438	0	59.438	0
Log (books)	1.792	62.690	112.325	1.792	62.690	112.325
Male × Log (books)	1.792	–33.304	–59.672	0	–33.304	0
			112.091			*112.325*
500+ books (7)						
Male	1	59.438	59.438	0	59.438	0
Log (books)	1.946	62.690	112.989	1.946	62.690	121.989
Male × Log (books)	1.946	–33.304	–64.806	0	–33.304	0
			116.621			*121.989*

Note. The log of books corresponds to the log of the value associated with the interval; for example; 101–250 books takes a value of 5, and log (5) = 1.792.

Appendix 6

Table A6.1. Description of Content of the 1999 Junior Certificate English Examination Papers, by Syllabus Level, Text, and Task

Foundation	*Ordinary*	*Higher*
	Section 1: Reading	
Text: Four short paragraphs about spiders. Expository.	Text: Five short paragraphs about snakes. Expository.	Text: A one-and-a-half page extract from a Bill Bryson novel (travel writer), containing a lot of southern US slang and dialect.
Tasks: Two questions requiring retrieval of information, two questions requiring inference regarding word meaning, one question requiring judgement regarding suitability of title.	Tasks: One question requiring retrieval of information, one question requiring interpretation and inference, one question requiring students to infer reasons for word choice, one question requiring students to comment on the writing devices used to convey mood, and one question requiring students to infer something about the author.	Tasks: One question requiring inference about the author as a person, one question requiring inference of attitude and feelings of the characters and one question requiring students to identify and comment on humourous devices in the text.
	Section 2: Personal Writing	
Text: Seven possible composition titles (e.g., *When I Was Small*).	Text: Seven possible composition titles (e.g., *My First Job*) and a line drawing.	Text: Eight descriptions of possible compositions (e.g., Imagine you are present at a great event in history. Write out in diary form your personal reactions to the event). Students are free to write in any form (e.g. dramatic, short story etc.).
Task: Write a page on one of the topics.	Task: Write a composition (length unspecified) on one of the topics (titles or drawing).	Task: Write a composition (length unspecified) on one of the topics.
	Section 3: Functional Writing	
Text/Tasks: One of A or B. A: Requirement to give a talk to pupils in 6th class about five problems they will have when entering post primary school. B: Examine a given picture of a spider and describe it.	Text/Tasks: One of A or B. A: Requirement to write both the points and a speech for a debate about zoos. B: Write a response to one of three job advertisements.	Text/Tasks: One of A, B or C. A: Write the text to accompany given photos for a hotel brochure. B: Write a persuasive speech nominating the student of the year. C: Describe the given picture of a house as accurately as possible.
	Section 4: Fiction	
Text: Four short paragraphs from the novel *Robinson Crusoe* (previously unseen text).	Text: Four short paragraphs from the novel *ET: The Extra-Terrestrial* (previously unseen text).	Text: One-and-a-half pages from *Angela's Ashes* by Frank McCourt (previously unseen text).
Tasks: One question requiring retrieval of information, three questions requiring interpretation and inference, and one question requiring students to refer to a short story they studied and to describe aspects of the story's character, location or time period.	Tasks: Two questions requiring inferences about characters, one question requiring students to reflect on human qualities, one question requiring students to comment on the atmosphere of the text, and one question requiring students to refer to a short story they studied and to describe aspects of the story's characters and their relationship with each other, or, aspects of the story which were funny, sad or exciting.	Tasks: One question requiring inference about the character of the teacher in the text, one question requiring students to examine the text for exaggeration as a humourous device and one question requiring students to comment on the suitability of the extract as a basis for a film scene. The second section requires students to refer to a novel or short story they have studied and either comment on the devices used by the author to convey humour or tragedy, or to comment on the author's choice of the title for the novel.

Table A6.2. Comparison of Regression Coefficients for the Linear Associations (10 Separate Models) Between Student Overall Performance Scale (OPS) Scores) and Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy

	Raw Coefficient	*SE*	*Increase in GS per SD PISA**	*r*	*t*	*p*
Reading						
10 point scale	0.010	0.0002	0.96	**.729**	44.48	<.001
12 point scale	0.014	0.0003	1.27	**.742**	43.65	<.001
14 point scale	0.017	0.0004	1.59	**.737**	41.27	<.001
Mathematics						
10 point scale	0.014	0.0005	1.14	**.703**	29.22	<.001
12 point scale	0.018	0.0006	1.53	**.729**	32.86	<.001
14 point scale	0.023	0.0007	1.92	**.730**	35.02	<.001
16 point scale	0.028	0.0008	2.31	**.725**	34.36	<.001
*Science***						
8 point scale	0.011	0.0003	1.03	**.709**	34.30	<.001
9 point scale	0.014	0.0004	1.29	**.725**	36.65	<.001
10 point scale	0.017	0.0005	1.55	**.719**	35.81	<.001

Note. Significant correlations are highlighted in bold.

*These values are calculated using standard deviations and raw coefficients to five decimal places.

**Due to the fact that there are only two levels in science, the 8-point scale corresponds to the 10-point for English and Mathematics; the 9-point scale to the 12-point, etc.
N and percent missing: 38, 1.0% (for Reading); 24, 1.1% (for Mathematics); and 332, 15.6% (for Science).

A6.1. Detailed Description of PISA Test-Curriculum Rating Scales

Reading

- **Process:** The process scale requires raters to read through the text of the question and to rate how familiar they would expect the typical third year student to be with the *process underlying the question, i.e. the process which the question elicits*. Note that 'process' means *a particular reading skill in its abstract form.*[54] Thus raters are asked to identify the *abstract reading process* underlying the item and *not* to concern themselves with its application. Raters are also asked to identify the *specific* reading process underlying the item because this will make it easier to locate it within the English curriculum implemented in Ireland. In the event that multiple and interlinked underlying processes are identified, which can be expected in the case of English reading, a pragmatic and holistic approach is to be taken. That is, if one process, more so than others underlying a particular item, is deemed essential to respond to or find the answer to an item, then precedence should be given to that process in rating the process familiarity of the item. If processes are too interlinked to be separated, consider the rating as a global, holistic one, whereby it is not necessary to identify and separate the microprocesses underlying the item, but merely to assign a rating of your general impression of those processes. The question to be answered (for each syllabus level) is:

How familiar would you expect the typical third year student to be with the specific reading process(es) underlying this item?

[54] This is in contrast to *the act of understanding*, i.e. *the application of a particular reading skill in a specific instance*.

- **Context/Application:** The context/application scale requires raters to consider the stimulus text and the question and to rate how familiar they would expect the typical third year student to be with *applying the process(es) underlying the question* in the type of *context* suggested by the question and stimulus text. Context can be conceptualised in a number of ways, but the focus is on linguistic rather than subject matter context, i.e.: *genre, text length, density of information presented, and complexity of language presented*. The question to be answered (for each syllabus level) is:

  How familiar would you expect the typical third year student to be with the application of the specific reading process(es) underlying this item in the type of context (genre, text length, density, complexity) suggested by the item and stimulus text?

- **Format:** The format scale requires raters to read through the text of the question and to rate how familiar they would expect the typical third year student to be with *applying the process(es) in the type of format in which the question and accompanying stimulus text are presented.* Format refers to the layout of an item, the question type (e.g., multiple choice, free response), and the philosophy underlying its presentation, and as such is distinct from context. For example, some PISA reading items are multiple-choice, and the typical third year student would not be expected to be familiar with such a format. The question to be answered (for each syllabus level) is:

  How familiar would you expect the typical third year student to be with the application of the specific reading process(es) underlying this item in the type of format suggested by the item and stimulus text?

Mathematics

- **Concept:** The concept scale requires raters to read through the text of the question and rate how familiar they would expect the typical third year student to be with the *concept underlying the question*. Note that by 'concept' here, we mean *a mathematical principle in its abstract form.*[55] Thus raters are asked to identify the *abstract mathematical concept* underlying the item and *not* to concern themselves with its application for the concept scale. Raters are also asked to identify the *specific* mathematical concept underlying the item rather than at a more general level because this will make it easier to locate it within the mathematics curriculum implemented in Ireland. In the event that multiple and interlinked underlying concepts are identified, which can often happen in the case of mathematics, a pragmatic and holistic approach is to be taken. That is, if one concept, more so than others underlying a particular item, is deemed essential to respond to or find the answer to an item, then precedence should be given to that concept in particular in rating the concept familiarity of the item. The question to be answered (for each syllabus level) is:

  How familiar would you expect the typical third year student to be with the specific mathematical concept(s) underlying this item?

- **Context/Application:** The context/application scale requires raters to consider the stimulus text and the question and to rate how familiar they would expect the typical third year student to be with *applying the concept(s) underlying the question* in the type of *context* suggested by the question and stimulus text. Context can be conceptualised in a number of different ways, but the focus is at a fairly general level, i.e. whether students are familiar with the mathematical concept(s) being contexualised in this way, and whether the contextualisation of the question would be likely, based on the syllabus or

[55] This is in contrast to *the demonstration of understanding*, i.e. *the application of a mathematical principle in a specific instance*.

Junior Certificate Examination, to guide them to (or distract them from) the successful application of the concept. The question to be answered (for each syllabus level) is:

How familiar would you expect the typical third year student to be with the application of the specific mathematical concept(s) underlying this item in the type of context suggested by the item and stimulus text?

- **Format:** The format scale requires raters to read thought the text of the question and to rate how familiar they would expect the typical third year student to be with *applying the concept(s) in the type of format in which the question and accompanying stimulus text is presented.* Format refers to the *layout* of an item, the *question type* (e.g., multiple-choice, free response), and as such is distinct from context. For example, some PISA mathematics items may contain a long text passage; however, Irish students, who are used to more 'stark' exposition of mathematics problems, would not be familiar with a rich text-based format or presentation. The question to be answered (for each syllabus level) is:

  How familiar would you expect the typical third year student to be with the application of the specific mathematical concept(s) underlying this item in the type of format suggested by the item and stimulus text?

Science

- **Concept:** The concept scale requires raters to read through the text of the question and to rate how familiar they would expect the typical third year student to be with the *concept underlying the question*. Note that by concept here, we mean *a scientific principle in its abstract form.*[56] Thus raters are asked to identify the *abstract scientific concept* underlying the item and *not* to concern themselves with its application for the concept scale. Raters are also asked to identify the *specific* scientific concept underlying the item rather than at a more general level because this will make it easier to locate it within the science curriculum implemented in Ireland. In the event that multiple and interlinked underlying concepts are identified, which can often happen in the case of science, a pragmatic and holistic approach is to be taken. That is, if one concept, more so than others underlying a particular item, is deemed essential to respond to or find the answer to an item, then precedence should be given to that concept in particular in rating the concept familiarity of that item. The question to be answered (at each syllabus level) is:

  How familiar would you expect the typical third year student to be with the specific scientific concept(s) underlying this item?

- **Process:** Process differs from concept because, whilst concept requires raters to identify the specific scientific *principle(s)* underlying the question, the process scale requires raters to identify the *type of scientific reasoning* required to answer the question (e.g., inductive reasoning, deductive reasoning). The PISA science framework has identified five scientific processes. These may be of assistance in identifying the underlying process or processes for each item. Process is also distinct from context/application in that similar types of scientific reasoning can be applied in many different types of context. The question to be answered (at each syllabus level) is:

  How familiar would you expect the typical third year student to be with the specific scientific process(es) or type(s) of scientific reasoning underlying this item?

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[56] This is in contrast to *the demonstration of understanding*, i.e. *the application of a scientific principle in a specific instance*.

- **Context/Application:** The context/application scale requires raters to consider the stimulus text and the question and to rate how familiar they would expect the typical third year student to be with *applying the concept(s) underlying the question* in the type of *context* suggested by the question and stimulus text. Context can be conceptualised in a number of ways, but the focus is at a fairly general level, i.e. whether students are familiar with the scientific concept(s) being contexualised in this way, and whether the contextualisation of the question would be likely, based on the syllabus, to guide them to (or detract them from) the successful application of the concept. The question to be answered (at each syllabus level) is:

  How familiar would you expect the typical third year student to be with the application of the specific scientific concept(s) underlying this item in the type of context suggested by the item and stimulus text?

- **Format:** The format scale requires raters to read thought the text of the question and to rate how familiar they would expect the typical third year student to be with *applying the concept(s) in the type of format in which the question and accompanying stimulus text are presented.* Format refers to the *layout* of an item, the *question type* (e.g., multiple choice, free response), and as such is distinct from context.[57] For example, some PISA science items may be classed as 'complex multiple-choice', i.e. pick 'true' or 'false' for a number of statements given in a table. Irish students would not be familiar with applying scientific concepts in a format such as this, and would be more accustomed to short response, labelling diagrams, etc. The question to be answered (at each syllabus level) is:

  How familiar would you expect the typical third year student to be with the application of the specific scientific concept(s) underlying this item in the type of format suggested by the item and stimulus text?

Table A6.3. Percentages of Items By Scale and Syllabus Level on Which There Was a Lack of Consensus (Initial Ratings): Reading Literacy (N = 141), Mathematical Literacy (N = 32) and Scientific Literacy (N = 35)

Domain	*Process Higher*	*Process Ordinary*	*Process Foundation*	*Concept Higher*	*Concept Ordinary*	*Concept Foundation*	*Context/Application Higher*	*Context/Application Ordinary*	*Context/Application Foundation*	*Format Higher*	*Format Ordinary*	*Format Foundation*
Reading	12.5	18.4	41.2	—	—	—	15.4	14.0	16.9	32.4	19.9	11.0
Maths	—	—	—	25.0	21.9	9.4	9.4	12.5	3.1	9.4	9.4	9.4
Science	11.4	11.4	—	20.0	8.5	—	8.6	5.7	—	25.7	25.7	—

[57] In fact, a decision was made at the science consensus meeting to focus on the question layout *only* due to the risk of confounding ratings on this scale with those on the context/application scale. This is also the case with reading, and largely the case with mathematics.

Table A6.4. Percentages of Original, Consensus and Final Ratings Assigned to Reading Literacy Items, by Rater, Scale, and Syllabus Level (N items = 141)

	Not Familiar		*Somewhat Familiar*		*Very Familiar*	
Process Higher	*Original*	*Consensus*	*Original*	*Consensus*	*Original*	*Consensus*
Rater 1	2.9	2.2	22.1	22.8	75.0	75.0
Rater 2	16.2	9.6	9.6	14.0	74.3	76.5
Rater 3	5.9	2.9	23.5	23.5	70.6	73.5
Final		3.7		14.7		81.6
Process Ordinary						
Rater 1	9.6	7.4	58.1	59.6	32.4	33.1
Rater 2	16.2	12.5	12.5	22.8	71.3	65.4
Rater 3	17.6	12.5	26.5	31.6	55.9	55.9
Final		9.6		36.8		53.7
Process Foundation						
Rater 1	50.0	30.9	42.6	61.8	7.4	7.4
Rater 2	24.3	21.3	16.2	37.5	59.6	41.2
Rater 3	32.4	28.7	29.4	33.8	38.2	37.5
Final		25.0		47.1		27.9
Context/Application Higher						
Rater 1	6.6	4.4	26.5	35.3	66.9	60.3
Rater 2	16.9	16.2	10.3	11.0	72.8	72.8
Rater 3	20.6	14.7	31.6	39.0	47.8	46.3
Final		13.2		25.7		61.0
Context/Application Ordinary						
Rater 1	8.1	7.4	68.4	74.3	23.5	18.4
Rater 2	17.6	17.6	36.0	40.4	46.3	41.9
Rater 3	33.1	27.9	32.4	39.0	34.6	33.1
Final		18.4		54.4		27.2
Context/Application Foundation						
Rater 1	61.0	58.8	33.8	40.4	5.1	0.7
Rater 2	45.6	42.6	48.5	53.7	5.9	3.7
Rater 3	50.7	50.7	27.2	36.0	22.1	13.2
Final		50.7		47.1		2.2
Format Higher						
Rater 1	8.1	48.5	27.2	14.7	64.7	36.8
Rater 2	52.9	50.7	9.6	11.8	37.5	37.5
Rater 3	50.7	48.5	19.1	21.3	30.1	30.1
Final		50.0		15.4		34.6
Format Ordinary						
Rater 1	11.0	49.3	62.5	38.2	26.5	12.5
Rater 2	53.7	51.5	18.4	22.1	27.9	26.5
Rater 3	52.2	50.0	19.9	22.1	27.9	27.9
Final		52.2		23.5		24.3
Format Foundation						
Rater 1	58.8	76.5	36.8	19.1	4.4	4.4
Rater 2	66.2	65.4	28.7	29.4	5.1	5.1
Rater 3	48.5	47.8	34.6	42.6	16.9	9.6
Final		72.1		22.8		5.1

Table A6.5. Percentages of Original, Consensus and Final Ratings Assigned to Mathematical Literacy Items, by Rater, Scale, and Syllabus Level (N items = 32)

	Not Familiar		*Somewhat Familiar*		*Very Familiar*	
Concept Higher	*Original*	*Consensus*	*Original*	*Consensus*	*Original*	*Consensus*
Rater 1	25.0	18.8	28.1	40.6	46.9	40.6
Rater 2	21.9	28.1	37.5	37.5	40.6	34.4
Rater 3	50.0	34.4	31.3	46.9	18.8	18.8
Final		31.3		40.6		28.1
Concept Ordinary						
Rater 1	28.1	21.9	31.3	43.8	40.6	34.4
Rater 2	21.9	28.1	46.9	46.9	31.3	25.0
Rater 3	62.5	50.0	25.0	37.5	12.5	12.5
Final		34.4		46.9		18.8
Concept Foundation						
Rater 1	46.9	40.6	31.3	40.6	21.9	18.8
Rater 2	43.8	43.8	40.6	43.8	15.6	12.5
Rater 3	75.0	62.5	21.9	34.4	3.1	3.1
Final		53.1		37.5		9.4
Context/Application Higher						
Rater 1	59.4	59.4	37.5	40.6	3.1	0.0
Rater 2	81.3	81.3	15.6	18.8	3.1	0.0
Rater 3	62.5	62.5	25.0	34.4	12.5	3.1
Final		71.9		28.1		0.0
Context/Application Ordinary						
Rater 1	71.9	71.9	28.1	28.1	0.0	0.0
Rater 2	81.3	81.3	15.6	18.8	3.1	0.0
Rater 3	81.3	81.3	9.4	18.8	9.4	0.0
Final		75.0		25.0		0.0
Context/Application Foundation						
Rater 1	75.0	75.0	25.0	25.0	0.0	0.0
Rater 2	81.3	81.3	15.6	15.6	3.1	3.1
Rater 3	87.5	87.5	9.4	12.5	3.1	0.0
Final		81.3		18.8		0.0
Format Higher						
Rater 1	56.3	50.0	40.6	50.0	3.1	0.0
Rater 2	62.5	65.6	34.4	34.4	3.1	0.0
Rater 3	68.8	65.6	21.9	28.1	9.4	6.3
Final		53.1		46.9		0.0
Format Ordinary						
Rater 1	68.8	62.5	28.1	37.5	3.1	0.0
Rater 2	68.8	71.9	28.1	28.1	3.1	0.0
Rater 3	81.3	78.1	9.4	15.6	9.4	6.3
Final		78.1		21.9		0.0
Format Foundation						
Rater 1	75.0	65.6	21.9	34.4	3.1	0.0
Rater 2	65.6	65.6	28.1	31.3	6.3	3.1
Rater 3	84.4	78.1	12.5	18.8	3.1	3.1
Final		71.9		28.1		0.0

Table A6.6. Percentages of Original, Consensus and Final Ratings Assigned to Scientific Literacy Items, by Rater, Scale, and Syllabus Level (N items = 35)

	Not Familiar		*Somewhat Familiar*		*Very Familiar*	
Concept Higher	*Original*	*Consensus*	*Original*	*Consensus*	*Original*	*Consensus*
Rater 1	57.1	42.9	34.3	45.7	8.6	11.4
Rater 2	45.8	51.4	11.4	11.4	42.8	37.1
Rater 3	54.3	48.6	17.1	22.9	28.6	28.6
Final		48.6		22.9		28.6
Concept Ordinary						
Rater 1	57.1	51.4	34.3	37.1	8.6	11.4
Rater 2	44.3	60.0	21.4	21.4	34.3	28.6
Rater 3	62.9	54.3	17.1	22.9	20.0	22.9
Final		54.3		22.9		22.9
Process Higher						
Rater 1	14.3	11.4	77.1	80.0	8.6	8.6
Rater 2	2.9	2.9	57.1	62.9	40.0	34.3
Rater 3	22.9	14.3	60.0	68.6	17.1	17.1
Final		8.6		74.3		17.1
Process Ordinary						
Rater 1	14.3	11.4	77.1	80.0	8.6	8.6
Rater 2	2.9	2.9	57.1	62.9	40.0	34.3
Rater 3	25.7	17.1	57.1	65.7	17.1	17.1
Final		8.6		74.3		17.1
Context/Application Higher						
Rater 1	65.7	74.3	28.6	20.0	5.7	5.7
Rater 2	82.9	82.9	0.0	5.7	17.1	11.4
Rater 3	60.0	77.1	31.4	14.3	8.6	8.6
Final		80.0		11.4		8.6
Context/Application Ordinary						
Rater 1	65.7	74.3	28.6	20.0	5.7	5.7
Rater 2	85.8	82.9	0.0	5.7	14.2	11.4
Rater 3	65.7	77.1	25.7	14.3	8.6	8.6
Final		80.0		11.4		8.6
Format Higher						
Rater 1	62.9	42.9	37.1	45.7	0.0	11.4
Rater 2	60.0	45.7	0.0	20.0	40.0	34.3
Rater 3	65.7	42.9	11.4	20.0	22.9	37.1
Final		42.9		22.9		34.3
Format Ordinary						
Rater 1	62.9	42.9	37.1	45.7	0.0	11.4
Rater 2	60.0	45.7	0.0	20.0	40.0	34.3
Rater 3	65.7	42.9	11.4	20.0	22.9	37.1
Final		42.9		22.9		34.3

Table A6.7. Formulae Used To Calculate Curriculum Ratings for Each Booklet, By Scale, Syllabus Level, and Domain

Booklet	*Reading*	*Mathematics*	*Science*
1	SLxRSx(R1+R2+R4)/3	SLyRSy(M1+M2)/2	—
2	SLxRSx(R2+R3+R5)/3	—	SLzRSz(S1+S2)/2
3	SLxRSx(R3+R4+R6)/3	SLyRSy(M3+M4)/2	—
4	SLxRSx(R4+R5+R7)/3	—	SLzRSz(S3+S4)/2
5	SLxRSx(R1+R5+R6)/3	SLyRSy(M2+M3)/2	—
6	SLxRSx(R2+r6+R7)/3	—	SLzRSz(S2+S3)/2
7	SLxRSx(R1+R3+R7+R8)/4	—	—
8	SLxRSx(R8+R9)/2	SLyRSy(M2+M4)/2	SLzRSz(S1+S3)/2
9	SLxRSx(R8+R9)/2	SLyRSy(M1+M3)/2	SLzRSz(S2+S4)/2

Notes.
SLx = Syllabus level for English, where x=Higher, Ordinary or Foundation
RSx = Reading Curriculum Scale, where x=Process, Concept/Application or Format
SLy = Syllabus level for mathematics, where y=Higher, Ordinary or Foundation
RSy = Mathematics Curriculum Scale, where y=Concept, Concept/Application or Format
SLz = Syllabus level for Science, where z=Higher or Ordinary
RSz = Science Curriculum Scale, where z= Concept, Process, Concept/Application or Format.

Table A6.8. Mean Ratings by Scale and Syllabus Level: All Domains, All Booklets

Booklet	*Process Higher*	*Process Ordinary*	*Process Foundation*	*Concept Higher*	*Concept Ordinary*	*Concept Foundation*	*Context/Application Higher*	*Context/Application Ordinary*	*Context/Application Foundation*	*Format Higher*	*Format Ordinary*	*Format Foundation*
Reading												
1	2.8241	2.5610	2.1560	—	—	—	2.6295	2.2467	1.6113	2.0156	1.8641	1.5655
2	2.8204	2.6037	2.1685	—	—	—	2.5241	2.4204	1.7611	2.1333	1.9222	1.5093
3	2.6974	2.4085	1.9935	—	—	—	2.5121	2.3072	1.5837	1.8425	1.6778	1.3575
4	2.6667	2.3277	1.9813	—	—	—	2.4190	2.0893	1.5107	1.9107	1.5407	1.4279
5	2.8196	2.5253	2.1665	—	—	—	2.6535	2.2216	1.5088	1.9034	1.7382	1.4025
6	2.7104	2.4549	2.0622	—	—	—	2.3578	2.0753	1.4563	1.9837	1.6667	1.5648
7	2.7625	2.5042	2.0991	—	—	—	2.5996	2.3445	1.7560	2.0259	1.7536	1.6033
8	2.6361	2.3417	1.9250	—	—	—	2.4500	2.1472	1.6306	2.0472	1.9667	1.6028
9	2.6361	2.3417	1.9250	—	—	—	2.4500	2.1472	1.6306	2.0472	1.9667	1.6028
Mathematics												
1	—	—	—	2.1042	1.8958	1.5625	1.5209	1.3333	1.3125	1.6250	1.4167	1.4375
3	—	—	—	1.9792	1.9167	1.6875	1.1250	1.1042	1.0834	1.4584	1.4584	1.4584
5	—	—	—	1.8959	1.7917	1.6459	1.2709	1.2292	1.2292	1.3750	1.3334	1.3125
8	—	—	—	2.0000	1.8333	1.5417	1.2709	1.2083	1.1875	1.5834	1.5417	1.5209
9	—	—	—	2.0834	1.9792	1.7084	1.3750	1.2292	1.2084	1.5000	1.3334	1.3750
Science												
2	2.1204	2.1019	—	1.9838	1.7362	—	1.3311	1.3311	—	1.9676	1.9676	—
4	2.0926	2.0926	—	1.5926	1.5926	—	1.2778	1.2778	—	1.7037	1.7537	—
6	2.1019	2.1019	—	1.6690	1.6065	—	1.1829	1.1829	—	1.9491	1.9491	—
8	2.0555	2.0370	—	1.6111	1.4260	—	1.2223	1.2223	—	1.8334	1.8334	—
9	2.1574	2.1574	—	1.9653	1.9028	—	1.3866	1.3866	—	1.8380	1.8880	—

Table A6.9. Factor Loadings and Percentages of Variance Explained by Principal Components Analyses of Curriculum Rating Scales

Scale	*Reading*	*Mathematics*	*Science (1)**		*Science (2)*
			Component 1	Component 2	
Concept		.818	.968	.113	.946
Process	.953		.932	–.078	.936
Context	.944	.782	.860	–.416	.905
Format	.825	.766	.346	.930	
% Variance Explained	82.7	62.2	66.6	26.4	86.3

*The Kaiser-Meyer-Olkin (KMO) value, which gives an indication of the magnitude of the partial correlations between variables, for the science format scale, at .202, was too low to justify retaining the format scale in the combined science scale (minimum acceptable value = .50). Hence the second principal components analysis for science (science 2) includes only the science concept, process and context scales, and a single component.

Appendix 7

Note: There is no additional information corresponding to Chapter 7 (Summary and Conclusions)

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