Ready for Life?

THE LITERACY ACHIEVEMENTS OF IRISH 15-YEAR OLDS
WITH COMPARATIVE INTERNATIONAL DATA

SUMMARY REPORT

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Contents

Preface

International studies of educational achievement are designed to provide information on the outcomes of education to individuals and organisations involved in all aspects of the educational enterprise, including policy makers, managers, teachers and the general public. More specifically, such 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 programme involving 15-year old students in second-level schools, the OECD Programme for International Student Assessment (PISA), was implemented 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 associated with achievement. 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' achievements 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 on mathematical literacy (in 2003) and scientific literacy (in 2006), and to describe trends in achievement in the three domins over time. It is also planned to assess students' cross-curricular problem-solving skills (in 2003) and their knowledge of information and communication technologies (ICTs) (in 2006).

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

This summary is being published in conjunction with two other reports: an international report, *Knowledge and Skills for Life: First Results of PISA 2000* (OECD, 2001), and a national report for Ireland, *Ready for Life? The Literacy Achievements of Irish 15-year Olds With Comparative International Data* (Shiel, Cosgrove, Sofroniou & Kelly, 2001). The purpose of the national report (the findings of which are summarised in this document) is to provide a more detailed description and interpretation of the performance of Irish students, and to consider how the outcomes of PISA might contribute to the development of educational policy in Ireland. Student performance on the assessment is compared with the performance of Irish students in earlier international studies, and links between the PISA assessment and Junior Cycle syllabi and Certificate Examinations are examined. Relationships between performance on the PISA assessment and student and school variables are also described.

Thanks are extended to the principals, staff and students who participated in the PISA 2000 assessment. Without their co-operation and support the study would not have been possible. In total, 139 schools and almost 4,000 students participated in the main study (March 2000). We would also like to acknowledge the work of the 42 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 a preliminary field trial (March 1999), and whose responses and comments assisted greatly in the refinement of instruments and procedures for the main study.

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

Thanks are extended to the PISA 2000 consortium, especially Ray Adams (Australian Council for Educational Research), Christian Monseur (ACER) and Keith Rust (Westat, USA), and to Andreas Schleicher (OECD), for advice on technical aspects. We would also like to acknowledge the advice of Murray Aitkin (University of Newcastle) on weighting in generalized linear mixed models; James K. Lindsey (Limburgs Universitair Centrum, Diepenbeek, Belgium) for providing the Generalised 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., USA.) for advice on numerical computation.

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Key Findings

Context

- The OECD[1] Programme for International Student Assessment (PISA) was implemented with nationally representative samples of 15-year olds in 28 member countries and four additional countries in 2000.
- In Ireland, the assessment was jointly implemented by the Educational Research Centre, Dublin and the Department of Education and Science. Altogether, 139 schools and 3,854 students took part.
- Students completed a comprehensive paper-and-pencil test of reading literacy (the major domain), and less comprehensive tests of mathematical literacy and of scientific literacy (the minor domains). Students and principal teachers also completed short questionnaires that provided information on variables associated with achievement at student and school levels.
- The PISA assessment focuses on knowledge and skills required for future life, rather than on the outcomes of specific school curricula.
- An international report on the study, *Knowledge and Skills for Life: First Results of PISA 2000*, has been released by the OECD.
- A national report for Ireland, *Ready for Life? The Literacy Achievements of Irish 15-year olds with Comparative International Data* (Shiel, Cosgrove, Sofroniou, & Kelly, 2001) has been published by the Educational Research Centre.

Reading Literacy

- Irish 15-year olds achieved the fifth highest mean score on a combined reading literacy scale among the 27 OECD countries that met agreed criteria on school and student participation levels. Students in only one country (Finland) achieved a significantly higher mean. Students in Australia, Canada, Japan, Korea, Sweden, the United Kingdom, and New Zealand achieved mean scores that do not differ significantly from the mean score of students in Ireland.
- The mean scores of Irish students on reading subscales that assessed ability to *Retrieve Information* and *Interpret Texts* were about the same as on the combined reading scale. Again, only students in Finland achieved significantly higher mean scores than Irish students.
- Ireland ranked third on a subscale that assessed ability to *Reflect On and Evaluate Texts*. The mean score of Irish students does not differ significantly from the mean score of Canadian students, who had the highest score 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. The scores of Irish students at the national 10th and 90th percentiles are also significantly higher than the corresponding OECD country average scores at these points.
- Smaller proportions of Irish students achieved scores at the lowest levels of proficiency on the combined reading literacy scale, and larger proportions achieved scores at the highest levels, compared to the OECD country average proportions. For example, 11% of Irish students achieved Level 1 or below, compared to an OECD country average of just over 17%.

[1] Organisation for Economic Co-operation and Development, based in Paris.

Mathematical Literacy

- Ireland ranked 15th of 27 OECD countries on the mathematical literacy assessment (for which performance was reported on a single scale only), and achieved a mean score that does not differ significantly from the OECD country average.
- The highest scoring country (Japan) had a mean score that is over half a standard deviation[2] higher than the mean score of Irish students.
- The score of Irish students at the national 10th percentile is significantly higher than the OECD country average score at that marker, and ranked 14th.
- Irish students at the national 90th percentile achieved a score that is below the corresponding OECD country average. Ireland ranked 20th, indicating a relatively poor performance by higher-achieving students.
- Overall, Irish students did less well on the mathematical literacy assessment than on the reading literacy and scientific literacy assessments.

Scientific Literacy

- The mean score of Irish students on the scientific literacy assessment, which ranked 9th overall, is significantly higher than the OECD country average.
- Students in six countries, including the United Kingdom, Korea, and Japan, achieved significantly higher mean scores than students in Ireland, while students in five other countries, including Austria and Sweden, achieved mean scores that are not significantly different from the mean score of Irish students.
- 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 country average at that point.

Gender Differences

- In Ireland, female students outperformed male students on the combined reading literacy scale (by about one-third of a standard deviation), and on each of the reading subscales. The gender difference was largest on the Reflect/Evaluate scale (about two-fifths of a standard deviation).
- Male students are more strongly represented than females at the lowest proficiency levels on the combined reading literacy scale. The reverse pattern is apparent at the highest proficiency levels.
- Male students performed significantly better than female students (by about one-sixth of a standard deviation) on the assessment of mathematical literacy.
- Gender differences on the scientific literacy assessment are not significant.
- The gender differences observed in Ireland were similar to those observed in other OECD countries. Differences in reading literacy in favour of females were observed in all countries.

Variables Associated with Achievement on PISA

In Ireland, several variables were associated with achievement on the PISA assessment tasks. Some related to students themselves, while others related to their schools.

- *Home background*. Students of parents of high socioeconomic status achieved mean scores in the three assessment domains that are significantly higher than the mean scores of students of parents of low socioeconomic status. Students in homes with

[2] The standard deviation associated with a mean score provides an indication of the spread of scores around that mean, with two-thirds of scores falling within one standard deviation of the mean. Differences between mean scores can also be interpreted in terms of standard deviation units.

a positive educational environment (as measured by the amount of books in the home) achieved significantly higher mean scores in the three domains than students in homes with a less favourable educational environment. Students living in lone-parent households did significantly less well in all three domains than students not living in such households.

- *Reading habits and attitudes.* Students who held positive attitudes towards reading, engaged in moderate amounts of reading for enjoyment (30 to 60 minutes per day), and borrowed library books frequently, did significantly better on the combined reading literacy scale than students who held negative attitudes, and engaged in leisure reading and borrowed library books less often.
- *Dropout risk.* Students who indicated that they were likely to drop out of school before the end of second-level schooling (14%) achieved mean scores in the three assessment domains that were considerably lower than students who indicated they would not drop out.
- *Homework.* Students who completed their homework on time on most or all days achieved higher mean scores in all three assessment domains than students who completed homework on time less frequently.
- *Study of Science.* Students who took science as a subject at Junior Cycle level achieved a significantly higher mean score in scientific literacy than students who did not study science (the difference was about two-thirds of a standard deviation). However, the mean scientific literacy score of students who studied Ordinary level science at Junior Cycle does not differ significantly from the mean score of students who did not study science at Junior Cycle.
- *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 in mathematical literacy.
- *School Disadvantaged Status.* On average, students in schools in areas of educational disadvantage (as designated by the Department of Education and Science) did less well (by about one half of a standard deviation in each assessment domain) than students in schools not so designated.
- *School Climate.* Students in schools with high levels of negative student behaviour (an index of which was provided by school principals) did significantly less well on the combined reading literacy and scientific literacy scales (but not on the mathematical literacy scale) than students in schools with average levels.

Explaining Achievement on the PISA Assessment

Since many of the variables correlated with achievement are themselves inter-related, regression-based procedures (hierarchical linear models) were used to help improve inferences about the relative contributions of the variables to achievement at both school and student levels. The models developed at the Educational Research Centre confirmed the importance of a number of school- and student-level variables in explaining Irish students' achievements. At the school level, these included school type and school disadvantaged status. At the student level, they included parents' socioeconomic status, number of siblings, amount of books in the home, dropout risk, and frequency of completion of homework on time. The models indicated that gender differences cannot be adequately interpreted without considering how they interact with other variables. For example, female students in lone-parent households appeared to do less well on the mathematical literacy assessment than female students in other types of household, whereas the mathematical achievement of male students was not associated with household type. The models also showed that, while individual students' socioeconomic status was an important variable in explaining achievement, it was by no means the most powerful explanatory variable.

PISA and the Junior Cycle Syllabi/Junior Certificate Examination

An examination of the relationship between PISA assessment items and Junior Cycle syllabi/Junior Certificate Examinations revealed that, in the case of reading literacy, students studying all syllabus levels would be likely to be 'somewhat familiar' or 'very familiar' with the processes assessed by the majority of items and the contexts in which they were presented. Students were considered to be less likely to be familiar with the format of the reading literacy items. In the case of mathematical literacy, it was judged that students at all levels would be unfamiliar with the context and format of the majority of items, and 'somewhat familiar' or 'very familiar' with one-half to two-thirds of the items (depending on the syllabus studied) in terms of the concepts assessed. In the case of the scientific literacy assessment, it was judged that students would be 'somewhat familiar' or 'very familiar' with almost all scientific processes assessed by the items, and with about three-fifths of the item formats. However, it was considered likely that they would be unfamiliar with about half of the science concepts, and with four-fifths of the contexts in which the concepts were embedded.

An examination of the association between curriculum familiarity ratings and student achievement in reading literacy revealed moderately strong correlations between the ratings on process, context and format, and achievement. Familiarity with concept was more strongly associated with achievement in mathematical literacy than familiarity with context or format. Familiarity with concept was also more strongly associated with achievement in scientific literacy than familiarity with process, context, or format, for which correlations with achievement were very weak.

Correlations between students' performance on PISA and their performance on the Junior Certificate Examination in English, Mathematics and Science were moderately strong.

1. PISA: An Overview

The Programme for International Student Assessment (PISA) was developed by member countries of the Organisation for Economic Co-operation and Development (OECD) to generate internationally comparable indicators of student achievement in key aspects of literacy at or near the end of compulsory schooling, to provide a broad context in which countries can interpret their performance, and to focus and motivate educational reform and school improvement. PISA 2000 was implemented in 28 OECD member countries, including Ireland and in four additional countries in Spring/Autumn 2000 (Table 1.1). Further PISA assessments are planned for 2003 and 2006.

Table 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.

Focus and Key Features of PISA

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. In future assessments, these areas will assume the status of major domains, while reading literacy will become a minor domain (Table 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 which were administered in conjunction with the assessment. The school questionnaire, which was completed by principal teachers, focused on school management and organisational and resource variables that may be associated with performance, while the student questionnaire sought information on individual student variables (e.g., socioeconomic status, parents' education, attitudes towards and engagement in reading).

Unlike earlier international assessments involving school-age populations, which sought to measure students' achievements in the context 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 will 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. The key features of PISA 2000 are outlined in Table 1.3.

Table 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; Attitudes 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.

Table 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 background indicators relating results to student and school characteristics
- The development of trend indicators that can track changes over time

Samples of Schools and Students

The PISA main study was conducted in Ireland in March 2000. The target population comprised all 15-year old students (those born between January 1 and December 31, 1984) who were in full-time education in second-level schools, and whose teachers' salaries were funded by the Department of Education and Science. Students in special schools and in private schools were excluded. 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. A two-stage stratified sample design was used. In the first stage, schools in the sampling frame were grouped into three strata according to the total number of 15-year olds in the school. Within strata, schools were categorised by school type (secondary, community/comprehensive and vocational) and by gender composition (all boys, all girls, and mixed) and were selected with probability proportional to size.

In all, 136 of 154 selected schools agreed to participate, giving a weighted response rate of 85.6%. Three replacement schools also agreed to take part, bringing the total to 139, and a weighted response rate of 87.5%.

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 language of the assessment (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 the assessment, yielding a weighted response rate of 85.6%. Response rates at both the school and student levels in Ireland exceeded internationally agreed standards.

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 and Marking of Assessments

Assessment instruments were administered to selected students in their own schools by inspectors of the Department of Education and Science 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. The assessment lasted 120 minutes. Up to 40 minutes was required for students to complete a questionnaire.

Senior inspectors monitored the testing sessions in 21 schools, and reported directly to the PISA consortium on matters such as the suitability of conditions in which assessments were carried out, the timing of assessment sessions, and whether or not major disruptions occurred during assessment 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. Inter-rater reliability coefficients among the Irish markers were comparable to those reported for other OECD countries.

2. Performance in Reading Literacy

In reading literacy, students' understanding of a range of texts, continuous (descriptions, narrations and essays) and non-continuous (charts, diagrams, maps, forms and tables), was assessed. Performance is 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. Performance is also reported in terms of proficiency levels on the combined scale and on the three subscales.

> ***What is Reading Literacy?***
> In PISA, 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, 1999, p. 20)

Ireland achieved the fifth highest mean score (526.7) among the 27 OECD countries that met agreed criteria on school and student participation levels (Table 2.1). Just one country (Finland) achieved a significantly higher mean. The countries with mean scores that do not differ significantly from Ireland's are Australia, Canada, Japan, Korea, Sweden, the United Kingdom, and New Zealand. Countries with significantly lower mean scores include France, Germany, Norway, and Switzerland.

Table 2.1. Country Mean Achievement Scores and Standard Deviations on Combined Reading Literacy

Country	*Mean (SE)*[3]	*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)***

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

Questions categorised as 'Retrieve' (retrieving information) require readers to achieve an initial understanding of a text. They include 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 include locating and selecting relevant information in a text, including, where appropriate, such elements as character, time and setting. Questions categorised as 'Interpret' (interpreting information) require readers to

[3] The Standard Error of Sampling (SE) 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.

construct meaning and draw inferences using information from one or more parts of a text. Questions categorised as 'Reflect/Evaluate' (reflecting on and evaluating content and form) require readers to move beyond the text given and relate a text to one's experience, knowledge and ideas in evaluating its structure, content, or style.[4]

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). 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 (Table 2.2). Finland, the country with the highest mean score, has 6.9% at Level 1 or below and 18.5% at Level 5.

Table 2.2. 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	Reading abilities not assessed by PISA.	3.1 *(0.45)*	6.0 *(0.13)*

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

[4] A detailed description of the knowledge and processes associated with the three reading literacy subscales may be found in the full report of which this document is a summary (Shiel et al., 2001), as well as in the international PISA report (OECD, 2001) and a document describing the PISA assessment frameworks (OECD, 1999).

The proportions 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% (Table 2.3).

Table 2.3. Percentages of Students Achieving Each Proficiency Level on the Retrieve, Interpret and Reflect/Evaluate Reading Subscales – Ireland and OECD

	Ireland			*OECD Country Averages*		
Level	*Retrieve*	*Interpret*	*Reflect/ Evaluate*	*Retrieve*	*Interpret*	*Reflect/ Evaluate*
	% (SE)	*% (SE)*	*% (SE)*	*% (SE)*	*% (SE)*	*% (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)*	21.0 *(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)*

Given the pattern of performance of Irish students on the reading literacy proficiency levels, it is not surprising that the mean scores on the combined reading literacy scale of Irish students at the national 10th and 90th percentiles (401.3 and 641.1, respectively) are significantly higher than the corresponding OECD country average scores (365.9 and 622.7, respectively) at these percentiles.

3. Performance in Mathematical and Scientific Literacy

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).[5] Performance was reported in terms of scores on a single scale only.

> ***What is Mathematical Literacy?***
> In PISA, 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, 1999, p. 41)

The performance of Irish students on the scale (mean = 502.9) does not differ significantly from the OECD country average (500.0). Ireland ranked 15th of 27 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 (Table 3.1). However, Irish students at the national 10th percentile achieved a score that is significantly higher than the OECD country average score at that marker (394.4 compared with 366.8), and ranked 14th. Irish students at the 90th percentile achieved a score that is below the corresponding OECD country average (606.2 compared with 624.8), and ranked 20th, indicating a relatively poor performance by higher-achieving students.

Table 3.1. Country Mean Achievement Scores and Standard Deviations on Mathematical Literacy

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)***

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

[5] More detailed descriptions of the knowledge and processes associated with the mathematical and scientific literacy scales may be found in OECD (2001), and in Shiel et al. (2001).

The assessment of scientific literacy, which was also less comprehensive than the assessment of 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.

> ***What is Scientific Literacy?***
> In PISA, scientific literacy is defined as '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, 1999, p. 60)

The mean score of Irish students on the scientific literacy scale (513.4) is significantly higher than the OECD country average (500.0). Ireland ranks 9th overall. Students in six countries, including the United Kingdom, 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 (Table 3.3). Thus, Ireland did comparatively better on the scientific literacy assessment than on the mathematical literacy assessment, but relatively less well than on the reading literacy assessment. The scientific literacy score of Irish students at the national 10th percentile (394.4) is significantly higher than the corresponding OECD average (368.5). However, Irish students at the national 90th percentile achieved a score (630.2) that is not significantly different from the OECD average at that point (626.9).

Associations between performances of Irish students in the three domains are quite strong: correlations of .82 between reading literacy and mathematical literacy, .90 between reading literacy and scientific literacy, and .83 between mathematical and scientific literacy, were observed.

Table 3.2. Country Mean Achievement Scores and Standard Deviations on Scientific Literacy

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

4. Correlates of Achievement

Gender Differences

Female students outperformed male students on the combined reading literacy scale (by one-third of a standard deviation), and on each of the reading subscales. The gender difference is largest on the Reflect/Evaluate scale (two-fifths of a standard deviation). Male students are more strongly represented than females at the lowest proficiency levels on the combined reading literacy 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 mathematical literacy scale. The gender difference in scientific literacy is not statistically significant.

Home Background Variables

Measures of home background variables representing combined parents' socioeconomic status (SES), combined parents' educational level, number of siblings, home educational resources (access to a dictionary, a desk/place to study and textbooks), and the number of books in the student's home (a measure of home educational environment) were associated with achievement in the three assessment domains. For example, students of parents of high SES achieved significantly higher mean scores in the three PISA domains than students of parents of low SES. 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.

Reading Habits and Attitudes

The student reading habits and attitudes most strongly associated with combined reading literacy are attitude towards reading, reading for enjoyment, 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 reading for enjoyment (30 to 60 minutes per day) are more strongly associated with achievement than larger amounts.

Table 4.1 shows the correlation coefficients between achievement scores and some key student-level variables, including those relating to reading habits and attitudes.

Table 4.1. Pearson's Correlation Coefficients Between Some Key Student Variables and Combined Reading Literacy, Mathematical Literacy, and Scientific Literacy Scores

	Combined Reading Literacy	*Mathematical Literacy*	*Scientific Literacy*
Number of Siblings	**–.121**	**–.108**	**–.146**
Combined Parent SES	**.314**	**.292**	**.306**
Combined Parents' Education	**.212**	**.238**	**.240**
Home Educational Resources	**.259**	**.286**	**.221**
Books in the Home	**.330**	**.323**	**.324**
Homework Done on Time	**.181**	**.160**	**.164**
Diversity of Reading	**.246**		
Borrowing Library Books	**.216**		
Reading for Enjoyment	**.262**		
Attitude towards Reading	**.426**		

Note. All correlations are significant beyond the .001 level.

Other Student Characteristics

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 one standard deviation lower than that of students not attending such classes, and also performed less well in mathematical and scientific literacy. Students who studied Higher level English obtained a mean reading literacy scores that was over one standard deviation higher than students who studied English at Ordinary level. Differences of similar magnitude were observed between the mean scores in mathematical and scientific literacy of students taking Higher and Ordinary level course in the respective subjects (mathematics and science). The difference between the performance of Higher and Foundation level students was around two standard deviations for both reading literacy and mathematical literacy. 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 (about 12% of students). Students who completed homework mostly or always on time (see Table 4.1) 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 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.

School Characteristics

Several school characteristics were found to be associated with achievement, including the following: 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 in 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 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 in reading literacy, but not in mathematical or scientific literacy).

School Resources And School Climate

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. Students in schools with high levels of negative student behaviour (as reported 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 (as reported 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.

5. Explaining Achievement

Since many of the variables correlated with achievement are themselves inter-related, multilevel regression-based procedures were used to help improve inferences about the relative contributions of the variables to achievement at both school and student levels. The proportions of variance in achievement that lie between schools are described before the results of the multilevel analyses are reported.

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 (Table 5.1). These estimates are well below the corresponding OECD country average percentages, suggesting 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.

Table 5.1. Percentages of Total Variance in Achievement in Reading, Mathematical, and Scientific Literacy That Lie Between Schools, by Country

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. 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.

Hierarchical (multilevel) linear models were developed for all three achievement domains. 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 attributable to the inclusion in the model of a number of variables that are specific to reading literacy, including attitude towards reading and frequency of reading for enjoyment.

The model for reading literacy includes three school-level variables (disciplinary climate, school type, and disadvantaged status), and 10 student-level variables (gender, socioeconomic status, number of siblings, index of books in the home, dropout risk, frequency of absence from school, frequency of completion of homework on time, grade level, frequency of reading for enjoyment, and attitude to reading), and a variable reflecting the interaction between gender and index of books in the home.

Since the model is additive, it is possible to estimate the contributions of combinations of variables. For example, a student attending a vocational school that is designated as disadvantaged and who is at risk of dropping out of school is expected to score, on average, one standard deviation lower in reading literacy compared to 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 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 .03 of a standard deviation for students categorised as having low SES (those in the bottom third). The model of reading literacy also includes a random slope for student dropout risk, implying that its effects on achievement are not constant across schools. The interaction term for gender and books in the home suggests that females with fewer books at home do less well than males with fewer books at home, whilst the trend is reversed for students with higher amounts of books at home (females do better).

The hierarchical linear models for mathematical literacy and scientific literacy are less complex than that the one for reading literacy. School type and disadvantaged status are the only school-level variables in these models. However, the two variables together account for sizeable proportions of between-school variance. Both models also include parents' combined socioeconomic status, number of siblings, index of books in the home, grade level, frequency of completion of homework on time, and dropout risk.

In the model for mathematical literacy, the effect of socioeconomic status is estimated to amount to just over one-half of a standard deviation for high SES students, over one-third for medium SES students, and one-quarter for low SES students. The contribution of this variable is substantial, given that combined parental educational attainment is also included in the model. The model also includes an interaction term between gender and lone-parent status, which indicates that, while there is no difference in the achievement of males from lone-parent and other types of household, females from lone-parent households do less well than females in other types of household.

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 almost one-half of a standard deviation. As in the case of the model of reading literacy, there is a significant interaction between gender and the index of books in the home.

6. Links between PISA and Junior Cycle Syllabi and Certificate Examinations

Because the focus of PISA moves away from school curricula to a broader conceptualisation of literacy, it was of interest to examine the links between the national syllabi for Junior Cycle and PISA, as well as between students' performance on the Junior Certificate examinations and their performance on PISA.

Curriculum experts (raters) indicated that the processes underlying the majority (75% or more) of PISA reading literacy items would be 'somewhat familiar' or 'very familiar' to students, regardless of the level of the syllabus they were studying. For students at Higher and Ordinary levels, they expected the contexts in which over 80% items were presented to be 'somewhat familiar' or 'very familiar'. According to the raters, Foundation level students should be somewhat or very familiar with the contexts of 50% of items. They also indicated that the format of 50% or more of the items would be unfamiliar to students at all three syllabus levels.

In the case of mathematical literacy, curriculum experts concluded that the concepts underlying about one-third of the assessment items would be unfamiliar to students at Higher and Ordinary levels, and over 50% would be unfamiliar to Foundation level students. For all three syllabus levels, the context in which about 75% of mathematical literacy items were presented would be unfamiliar to students. The formats in which mathematical literacy items were presented received similar ratings to the contexts.

In the view of the curriculum experts, the science topics underlying over two-fifths of the scientific literacy items did not appear on the Junior Certificate Science syllabus. However, it was thought that students at both Higher and Ordinary levels would be 'somewhat familiar' or 'very familiar' with the processes underlying over 90% of items. Similar to the mathematical literacy items, the contexts of four-fifths of the scientific literacy items were rated unfamiliar to students, while about three-fifths were considered to be somewhat or very familiar to students in terms of the format in which they were presented.

Curriculum familiarity ratings were also analysed at the student level and correlations between these ratings and performance on the PISA assessment were computed. The correlations between students' combined reading literacy scores and the three curriculum rating scales (familiarity with process, context, and format) are moderately strong (range = .46 to .55). In contrast, the curriculum 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).

An examination of correlations between students' performance on the Junior Certificate English, Mathematics, and Science Examinations and their performance on the PISA assessment revealed moderately strong relationships. In all three domains, correlations exceed .72. This suggests that, despite 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.

7. Conclusions and Implications

Conclusions

There are some differences between the performance of Irish students on PISA, and the performance of Irish students and adults in earlier international assessments.

In the IEA[6] Reading Literacy Study (IEA/RLS), Irish 14-year olds achieved a mean score close to that of the international median, and ranked 16th of 19 OECD countries (OECD, 1995). In PISA, Irish 15-year olds achieved a mean score that is significantly higher than the OECD country average, and ranked 5th of 27 OECD countries. There are a number of possible explanations for the relatively strong performance of Irish students in PISA. First, the PISA reading literacy framework and tests were broadly compatible with the Junior Certificate syllabus and with the Junior Certificate English Examination. Second, the PISA assessment included items that required students to reflect on, and evaluate, the content and form of texts, and Irish students did particularly well on them. 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 writing.

A comparison of the findings of the International Adult Literacy Survey (IALS) OECD/Statistics Canada, 2000) and of PISA indicates that the proportion of Irish adults who scored at the lowest proficiency level on IALS (22.6%) is greater than the proportion who scored at Level 1 and below on the PISA combined reading scale (11.0%). A variety of explanations may be offered to account for this discrepancy. These relate to participation rates (86% of selected students participated in PISA, while just 60% of selected adults participated in IALS); the educational attainment of respondents (over 20% of adults in IALS had not completed lower second-level education); differences in the reading processes tapped in the 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 stringent criteria).

A finding that is common to recent national assessments at primary level (e.g., Cosgrove et al., 2000) and the PISA assessment of reading literacy is that a proportion of students experience serious literacy difficulties. While the proportion of Irish students achieving Level 1 or below on the PISA combined reading literacy scale (11.0%) was lower than the OECD country average (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 just 6.9%.

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. The mean score for Irish students does not differ significantly from the international mean, and therefore is consistent with the earlier studies such as the International Assessment of Educational Progress II (IAEP II) (Martin, Hickey & Murchan, 1992) and Third International Mathematics and Science Study (TIMSS) (Beaton et al., 1996; OECD, 1997). However, a number of observations about the performance of Irish students in PISA can be made.

First, performance, relative to the that of students in other countries, was poorer in mathematical literacy than in reading or scientific literacy. Second, the performance of higher achieving students in Ireland (defined as the score at the 90th percentile) was poorer than in countries with mean achievement scores that do not significantly differ from the Irish mean.

[6] International Association for the Evaluation of Educational Achievement, based in The Hague.

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 syllabus, and so may have been unfamiliar to students. Second, almost one-half of the items assessed aspects of Measurement and Geometry, areas in which Irish students have done relatively poorly in earlier international assessments. Third, 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 Examination 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 the Junior Cycle syllabus at Ordinary or Foundation levels. Having said this, it 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 in some countries, where approaches consistent with realistic mathematics education have been implemented, this was probably not the case (e.g., in Australia, where students did particularly well on the PISA mathematics assessment).

Other factors may have affected the performance of students in Ireland. One relates to access to calculators during the assessment. Irish students who used a calculator achieved a mean score that was 25.2 points (0.30 of a standard deviation) higher than the mean of students who did not use one. Comparable data for other countries are not available.

Since mathematics was a minor domain in PISA 2000, it would be premature to suggest that the Junior Cycle mathematics syllabus should be modified to include a stronger emphasis on 'realistic mathematics' and 'real world' problem-solving tasks. PISA 2003 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 the current syllabus and approaches to assessment.

Irish students performed better on the PISA assessment of scientific literacy than students in earlier international assessments. 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 in post-primary schools achieved a mean score that did not differ significantly from the OECD average (OECD, 1997). 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, scientific knowledge was not assessed in the same way as in TIMSS or in earlier studies. Certain aspects of scientific knowledge (such as Physics and Chemistry) were not as strongly represented in PISA as they were in TIMSS, while others, such as Life and Earth sciences were more strongly represented.

Two additional factors merit consideration 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 Section 3). This perhaps reflects the fact that the scientific literacy test contains several long passages of text. To the extent that Irish students did very well in reading literacy, it might be expected that they would also do well on the scientific literacy tasks. The fact that they did not do as well may indicate a lack of the scientific concepts that were assessed. This hypothesis is in line with the observation that expert raters could not locate over 40% of the PISA items in the Junior Cycle syllabus, and judged 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 fact that some of them 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. 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 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 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 change 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 extent of the overlap between the content of the national curricula and related assessments in the UK and the PISA assessment may also be relevant.

A particularly interesting finding to emerge from the analysis of the Irish data on the performance of students on the scientific literacy assessment was that, while students who studied Junior Cycle science at Higher level achieved a significantly higher mean score 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 at all was not statistically significant. 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.

Between-school variance amounted to less than 18% of the total variance in achievement of Irish students in the three PISA domains. In the earlier IEA/RLS, the figure for 14-year olds was 48% (Postlethwaite & Ross, 1992) while in TIMSS, figures for second year students in second-level schools were 50% for mathematics and 38% for science. (Martin et al., 2000). However, comparisons across these studies are difficult due to differences in sampling procedures.

The hierarchical linear models for the three PISA assessment domains suggest 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 secondary schools).

The negative contribution of school disadvantaged status was also confirmed in the hierarchical linear models for all three domains. In reading literacy, for example, the contribution of disadvantaged status to achievement is –22.3 points (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.

While the hierarchical linear models explain 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 academic ability.

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 and the interaction between gender and lone parent status in the mathematical literacy model. These findings suggest a need to develop a more complex view of relationships between gender and achievement.

The results also suggest that an appraisal of the proportions of students taking Higher, Ordinary, and Foundation level Junior Certificate 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, 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, specification of an appropriate model and procedures to meet the needs of students taking the course, may mean that the distinction between Foundation and Ordinary levels is often blurred.

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. Third, the hierarchical linear models referred to above 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 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 fifth class (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. 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 (4.3% in 1999) suggests that more students might benefit from studying the Foundation Level course in English. The absence of a separate syllabus for Foundation level 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 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.

Mathematical Literacy

4. *Links between Junior Cycle syllabus, Junior Certificate Examination and performance on PISA mathematical literacy.* Future revisions of the Junior Cycle mathematics syllabus and Junior Certificate Examination should take account of 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 syllabus/examinations do not pay sufficient attention to developing and assessing students' problem-solving skills in the context of 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 mathematical literacy assessment needs to be considered in light of the differences between the Junior Cycle syllabus/Junior Certificate Examination 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*. The discrepancy between the percentages of students taking English (62.9% in 1999) and mathematics (32.0%) at Higher level in the Junior Certificate Examination needs to be examined in light of the strong performance of students in reading literacy in PISA, relative to their performance in mathematics.
7. *Interpreting 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 mathematics indicates that the effects of gender might be considered in conjunction with lone-parent status. 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 use 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 reading literacy, their 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 assessment of scientific literacy of Irish students who had not studied science at Junior Cycle (11%), and the negligible difference in achievement between students who studied science at Junior cycle and those who did not, are matters of concern, and again suggest that these some students in the system 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, 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 findings 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 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.* 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 when other variables such as a school's 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 case 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. *Dropout risk*. Poor performance in all three achievement domains of students who are at risk of dropping out of school prior to completing upper secondary education reinforces the view that at-risk students should be identified as early as possible (preferably 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, may be instructive in this regard. The finding that the effect of dropout risk on achievement is large supports the establishment of pilot intervention programmes to address this problem.
15. *Home educational environment.* The index of books in the home, which may be taken as a measure of home educational environment, was associated with 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 confirming the importance of securing home involvement in programmes to address the needs of students in disadvantaged backgrounds.

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Additional Publications on PISA 2000

Ready for Life? The Literacy Achievements of Irish 15-Year Olds with Comparative International Data [ISBN 0-9004400-9-0] provides a detailed interpretation of the performance of Irish students in the PISA assessment and considers how the outcomes might contribute to the development of educational policy in Ireland. Available from the Educational Research Centre, St Patrick's College, Dublin 9. [Online order form at: www.erc.ie/pisa]

Knowledge and Skills for Life: First Results of PISA 2000 [ISBN 92-64-19671-4] is the international report produced by the OECD which presents a more broadly focused discussion of the international findings of PISA 2000. Available online at www.pisa.oecd.org. Hardcopy can be ordered online at www.SourceOECD.org.

Measuring Student Knowledge and Skills: A New Framework for Assessment [ISBN 92-64-17053-7] describes the background to PISA with a particular focus on how Reading, Mathematics and Science are defined, measured and analysed. Available online at www.pisa.oecd.org. Hardcopy can be ordered online at www.SourceOECD.org.