SCOTTISH EXECUTIVE

Education Department

Programme for International Student Assessment

Scottish Report

Education and Young People Research Unit

Executive Summary

The Performance of 15 Year Olds in Reading Literacy, Mathematical Literacy and Scientific Literacy

OECD set up the Programme for International Student Assessment (PISA) to assess the performance of 15 year olds in reading literacy, mathematical literacy and scientific literacy in its member countries (some non-OECD countries also participated). The first of three phases of the study took place in 2000, when reading literacy was the main area assessed, with mathematical and scientific literacy being the minor domains.

Scotland was in the top third of countries in all subjects assessed. The results indicated that Scotland's 15 year olds performed significantly better in terms of attainment in mathematics and science than our 9 and 13 year olds did in earlier international studies, and this is likely to be the case in reading too.

Analysis of factors affecting student performance internationally showed that:

❏ Although much of the variation in student performance between countries was related to per capita GDP, the actual spend on education was less important.

❏ Students with more positive views on school performed better in reading, but more than 25% of students did not want to go to school and most felt bored there.

❏ UK students rated support from their teachers highly, but this was only weakly related to attainment.

❏ Both head teachers and students agreed that a supportive and encouraging climate encourages learning, but their views differed on obstacles to learning.

❏ Good educational resources in schools promoted learning significantly, but the quality of schools' infrastructure was not related to student performance.

❏ Schools with greater autonomy and more teacher involvement in management achieved higher reading performance.

❏ Teachers' relationships with pupils were related to learning, but the relationship between teacher morale and student performance was weak.

❏ Both competitive and co-operative learning approaches were positively related to student performance, indicating that both teaching approaches should be used.

❏ Homework was related to student performance, but it seemed to be fully effective only when more than a certain level of time was invested in it.

❏ The provision and use of computers in schools seemed to benefit teaching and learning. Reading literacy was higher for students more interested in and comfortable with computer use.

❏ Students' reading for enjoyment was positively related to performance and this should be encouraged as a means of improving reading skills. The time spent on this by students was low.

❏ Female students performed much better in reading literacy, while male students tended to perform better in mathematics. There were few gender differences in science. It appears that there are policies and practices which could reduce gender-related inequalities.

❏ The socio-economic background of students was strongly related to their attainment. There is a continuing need to tackle problems of poverty and deprivation if students are to achieve their full potential.

❏ Communication between parents and students was positively related to attainment and should be encouraged to assist in the development of language skills.

❏ The increasing level of education of parents is likely to affect their children's attainment positively.

❏ Students from one-parent families performed more poorly than other students. There is a need to facilitate productive home support for these children's learning in ways that do not demand more time and resources than single parents can afford.

❏ The presence in students' homes of possessions related to classical culture was positively related to their performance, but this cannot be equated with cultural activities in schools.

Introduction

The Programme for International Student Assessment (PISA) was set up by the OECD to assess the performance of 15 year olds in reading literacy, mathematical literacy and scientific literacy in its member countries. The results are intended to contribute school outcome measures for the OECD educational indicators programme. PISA is a three phase study with the first phase in 2000, the second in 2003 and the third in 2006. In 2000 the main domain assessed was reading literacy and mathematical literacy and scientific literacy were subsidiary domains. This means there were more reading literacy test items than mathematical literacy or scientific literacy ones. In 2003 mathematical literacy will be the main domain and in 2006 scientific literacy will be the main domain. The domains covered by PISA are defined in terms of:

❏ The content or structure of knowledge that students need to acquire.

❏ The processes that need to be performed.

❏ The contexts in which knowledge and skills are applied.

PISA looked at young people's ability to use their knowledge and skills in order to meet real-life challenges rather than how well they had mastered a specific school curriculum. For instance, PISA defines reading literacy as the ability to understand, use and reflect on written texts to participate effectively in life.

PISA provides a broad assessment of comparative learning outcomes towards the end of compulsory schooling. This can guide policy decisions and provide insights into the factors that contribute to the development of knowledge and skills, and the extent to which these factors are common to different countries. In the 2003 and 2006 studies a proportion of the test items from the previous study will be retained to provide a measure of performance change over time.

Design of PISA

In 2000 over a quarter of a million students took part in PISA from the 32 participating countries (one OECD country's results are not included in this report and four non-OECD countries participated). A further 13 countries will undertake PISA in 2002. PISA used pencil and paper assessments, lasting two hours for each student, including multiple choice questions and questions requiring students to construct their answers. Each student's assessment tasks were drawn from a total of seven hours of assessment items with different students taking different combinations of these items. Students also completed a questionnaire that took about 30 minutes and head teachers completed a questionnaire about their schools. In Scotland the testing sessions were supervised by the schools whereas in most other countries, including England and Northern Ireland, external administrators were used.

In Scotland our intended school sample was 120 and we received completed tests and questionnaires from 99 schools, an 82% response rate, which was within the PISA sampling limit. The sample of schools was drawn as a stratified, random sample representative of all secondary schools in Scotland. In total over 2500 students in the sample schools completed tests and questionnaires, the sample drawn randomly from students with a date of birth during a specified period.

Performance of Students

Student Proficiency in Reading Literacy

Reading literacy was measured on three scales - on retrieving information, on interpreting and on reflecting and evaluating. The scores on each scale represent degrees of proficiency in particular aspects of reading literacy. Each of the three reading literacy scales is divided into six levels of knowledge and skills. Level 5 corresponds to a score of more than 625, level 4 to scores in the range 553 to 625, level 3 to scores from 481 to 552, level 2 to scores from 408 to 480, level 1 to scores from 335 to 407. Students at a particular level not only demonstrate the knowledge and skills associated with that level but also the proficiencies required at lower levels. Students scoring below 335 points are not able to show the most basic skills that PISA sought to measure. Such performance should not be interpreted to mean those students have no literacy skills at all, but they could be said to have serious deficiencies in their ability to use reading literacy as a tool for the acquisition of knowledge and skills in other areas.

Students performing at the highest PISA proficiency level are likely to enhance their country's pool of talent. In the combined OECD area just under 10% of students were proficient at this level, level 5. More than 15% were proficient at this level in Australia, Canada, Finland, New Zealand, and the UK but only 5% or fewer were at this level in Brazil, Greece, Latvia, Luxembourg, Mexico, Portugal, the Russian Federation and Spain. In terms of countries Scotland was ranked seventh in terms of the percentage of students operating at this level.

The percentage of students operating below level 1 throughout the OECD was just over 6%. In Scotland the percentage was 3.3% and we were ranked joint seventh lowest of the countries in terms of this percentage. The three countries with the greatest percentages of students below level 1 were Brazil, Mexico and Luxembourg.

Table 1

Percentage of students at each level of proficiency on the combined reading literacy scale

Country	Proficiency levels											
	Below Level 1		Level 1		Level 2		Level 3		Level 4		Level 5	
Combined reading literacy scale	Percen-tage	S.E. *	Percen-tage	S.E.	Percen-tage	S.E.	Percen-tage	S.E.	Percen-tage	S.E.	Percen-tage	S.E.
OECD Countries												
Australia	3.3	0.5	9.1	0.8	19.0	1.1	25.7	1.1	25.3	0.9	17.6	1.2
Austria	4.4	0.4	10.2	0.6	21.7	0.9	29.9	1.2	24.9	1.0	8.8	0.8
Belgium	7.7	1.0	11.3	0.7	16.8	0.7	25.8	0.9	26.3	0.9	12.0	0.7
Canada	2.4	0.3	7.2	0.3	18.0	0.4	28.0	0.5	27.7	0.6	16.8	0.5
Czech Republic	6.1	0.6	11.4	0.7	24.8	1.2	30.9	1.1	19.8	0.8	7.0	0.6
Denmark	5.9	0.6	12.0	0.7	22.5	0.9	29.5	1.0	22.0	0.9	8.1	0.5
England	3.6	0.4	9.2	0.6	19.7	0.7	27.6	1.0	24.2	1.1	15.6	1.1
Finland	1.7	0.5	5.2	0.4	14.3	0.7	28.7	0.8	31.6	0.9	18.5	0.9
France	4.2	0.6	11.0	0.8	22.0	0.8	30.6	1.0	23.7	0.9	8.5	0.6
Germany	9.9	0.7	12.7	0.6	22.3	0.8	26.8	1.0	19.4	1.0	8.8	0.5
Greece	8.7	1.2	15.7	1.4	25.9	1.4	28.1	1.7	16.7	1.4	5.0	0.7
Hungary	6.9	0.7	15.8	1.2	25.0	1.1	28.8	1.3	18.5	1.1	5.1	0.8
Iceland	4.0	0.3	10.5	0.6	22.0	0.8	30.8	0.9	23.6	1.1	9.1	0.7
Ireland	3.1	0.5	7.9	0.8	17.9	0.9	29.7	1.1	27.1	1.1	14.2	0.8
Italy	5.4	0.9	13.5	0.9	25.6	1.0	30.6	1.0	19.5	1.1	5.3	0.5
Japan	2.7	0.6	7.3	1.1	18.0	1.3	33.3	1.3	28.8	1.7	9.9	1.1
Republic of Korea	0.9	0.2	4.8	0.6	18.6	0.9	38.8	1.1	31.1	1.2	5.7	0.6
Luxembourg	14.2	0.7	20.9	0.8	27.5	1.3	24.6	1.1	11.2	0.5	1.7	0.3
Mexico	16.1	1.2	28.1	1.4	30.3	1.1	18.8	1.2	6.0	0.7	0.9	0.2
New Zealand	4.8	0.5	8.9	0.5	17.2	0.9	24.6	1.1	25.8	1.1	18.7	1.0
Northern Ireland	5.1	0.6	10.2	0.7	19.3	0.9	25.3	1.3	23.6	1.2	16.4	1.1
Norway	6.3	0.6	11.2	0.8	19.5	0.8	28.1	0.8	23.7	0.9	11.2	0.7
Poland	8.7	1.0	14.6	1.0	24.1	1.4	28.2	1.3	18.6	1.3	5.9	1.0
Portugal	9.6	1.0	16.7	1.2	25.3	1.0	27.5	1.2	16.8	1.1	4.2	0.5
Scotland	**3.3**	**0.6**	**9.0**	**0.8**	**18.8**	**1.0**	**27.1**	**1.1**	**26.5**	**1.3**	**15.3**	**1.0**
Spain	4.1	0.5	12.2	0.9	25.7	0.7	32.8	1.0	21.1	0.9	4.2	0.5
Sweden	3.3	0.4	9.3	0.6	20.3	0.7	30.4	1.0	25.6	1.0	11.2	0.7
Switzerland	7.0	0.7	13.3	0.9	21.4	1.0	28.0	1.0	21.0	1.0	9.2	1.0
UK	**3.6**	**0.4**	**9.2**	**0.5**	**19.6**	**0.7**	**27.5**	**0.9**	**24.4**	**0.9**	**15.6**	**1.0**
USA	6.4	1.2	11.5	1.2	21.0	1.2	27.4	1.3	21.5	1.4	12.2	1.4
OECD total	*6.2*	*0.4*	*12.1*	*0.4*	*21.8*	*0.4*	*28.6*	*0.4*	*21.8*	*0.4*	*9.4*	*0.4*
Country average	*6.0*	*0.1*	*11.9*	*0.2*	*21.7*	*0.2*	*28.7*	*0.2*	*22.3*	*0.2*	*9.5*	*0.1*
Non-OECD Countries												
Brazil	23.3	1.4	32.5	1.2	27.7	1.3	12.9	1.1	3.1	0.5	0.6	0.2
Latvia	12.7	1.3	17.9	1.3	26.3	1.1	25.2	1.3	13.8	1.1	4.1	0.6
Liechtenstein	7.6	1.5	14.5	2.1	23.2	2.9	30.1	3.4	19.5	2.2	5.1	1.6
Russian Federation	9.0	1.0	18.5	1.1	29.2	0.8	26.9	1.1	13.3	1.0	3.2	0.5

* Standard Errors
The statistics in this report represent estimates of performance based on samples of students rather than on full populations. Each estimate has an associated degree of uncertainty which is expressed through a standard error. This provides a confidence interval with which to make inferences about population statistics. It can be inferred that the observed result would lie within the confidence interval in 95 out of 100 replications.

Table 2

*Mean scores in reading literacy ***

Country	Mean	
	Mean Score	SE
OECD Countries		
Australia	528	3.5
Austria	507	2.4
Belgium	507	3.6
Canada	534	1.6
Czech Republic	492	2.4
Denmark	497	2.4
England	523	3.0
Finland	546	2.6
France	505	2.7
Germany	484	2.5
Greece	474	5.0
Hungary	480	4.0
Iceland	507	1.5
Ireland	527	3.2
Italy	487	2.9
Japan	522	5.2
Republic of Korea	525	2.4
Luxembourg	441	1.6
Mexico	422	3.3
New Zealand	529	2.8
Northern Ireland	519	3.1
Norway	505	2.8
Poland	479	4.5
Portugal	470	4.5
Scotland	**526**	**3.8**
Spain	493	2.7
Sweden	516	2.2
Switzerland	494	4.3
UK	**523**	**2.6**
USA	504	7.1
OECD total	*499*	*2.0*
Country average	*500*	*0.6*
Non-OECD Countries		
Brazil	396	3.1
Latvia	458	5.3
Liechtenstein	483	4.1
Russian Federation	462	4.2

* As can be seen from Table 2, the precision of the results for Scotland, expressed by means of standard errors, is somewhat less than for a number of other countries, reflecting the relatively small sample size in Scotland. This, together with the difference in the arrangements for administering the tests means that Scotland's specific rankings need to be interpreted with caution. Small differences in scores should not be regarded as significant.

The top three performing countries on the combined reading literacy score were Finland, Canada and New Zealand. The mean combined score for reading for the UK shows that it is ranked sixth of the 31 countries included in Table 1 and was significantly above the mean for all OECD countries. The UK performance varied across the three sub domains assessed. In retrieving information the UK was ranked eighth, in interpreting it was ranked tenth and in reflecting and evaluating it was ranked second. Scotland was ranked sixth in terms of score on the combined reading scale and our score (526) was significantly above the OECD average.

In every country involved in PISA female students scored higher than male students on the combined reading literacy scale. The differences ranged from 14 points in the Republic of Korea to 53 points in Latvia. The score difference in Scotland was 30 points.

Student Proficiency in Mathematical Literacy

The test items used to assess mathematical literacy had a wide range of difficulty. The hardest items required creative mathematical thinking and insight, the less difficult ones required students to bring together and process information and the easiest ones required only a single processing step in a familiar context.

Due to the relatively small number of mathematical literacy test items mathematical literacy was not broken down into sub domains.

The three top performing countries on the mathematical literacy scale were Japan, the Republic of Korea and New Zealand. The UK was ranked joint seventh in mathematical literacy and the UK scored above the OECD mean score. Scotland's score (533) was ranked joint fifth.

In only three countries did female students score higher than male students - Iceland, New Zealand and the Russian Federation - but the differences were not significant. In all other countries male students scored higher than female students, the greatest differences (27 score points) being in the Republic of Korea, Austria and Brazil. In Scotland the score difference was 5 points in favour of male students.

Table 3

Mean scores in mathematical literacy

Country	Mean	
	Mean Score	S.E.
OECD Countries		
Australia	533	3.5
Austria	515	2.5
Belgium	520	3.9
Canada	533	1.4
Czech Republic	498	2.8
Denmark	514	2.4
England	529	2.9
Finland	536	2.2
France	517	2.7
Germany	490	2.5
Greece	447	5.6
Hungary	488	4.0
Iceland	514	2.3
Ireland	503	2.7
Italy	457	2.9
Japan	557	5.5
Republic of Korea	547	2.8
Luxembourg	446	2.0
Mexico	387	3.4
New Zealand	537	3.1
Northern Ireland	524	3.0
Norway	499	2.8
Poland	470	5.5
Portugal	454	4.1
Scotland	**533**	**3.7**
Spain	476	3.1
Sweden	510	2.5
Switzerland	529	4.4
UK	**529**	**2.5**
USA	493	7.6
OECD total	*498*	*2.1*
Country average	*500*	*0.7*
Non-OECD Countries		
Brazil	334	3.7
Latvia	463	4.5
Liechtenstein	514	7.0
Russian Federation	478	5.5

Student Proficiency in Scientific Literacy

The scientific literacy test items varied widely in terms of their difficulty. The hardest items required complex conceptual skills, the less hard ones required sound scientific thinking and the easier ones required recall and use of simple scientific knowledge.

Due to the fact there were relatively few scientific literacy test items no sub domain scores are available.

The three top performing countries on the scientific literacy scale were the Republic of Korea, Japan and Finland. The UK was ranked fourth on scientific literacy and scored significantly above the OECD average. Scotland's score (522) was ranked ninth. It is expected that the science strategy and the revised 5-14 curriculum guidelines developed in Scotland will help to redress this relative shortfall in student performance.

In 12 countries male students scored higher than female students by between one and 19 points. In two countries male and female students scored the same and in 17 countries female students scored higher than male students by between 2 and 23 points. In Scotland the score difference was 1 point in favour of male students.

Table 4

Mean scores in scientific literacy

Country	Mean	
	Mean Score	S.E.
OECD Countries		
Australia	528	3.5
Austria	519	2.6
Belgium	496	4.3
Canada	529	1.6
Czech Republic	511	2.4
Denmark	481	2.8
England	533	3.2
Finland	538	2.5
France	500	3.2
Germany	487	2.4
Greece	461	4.9
Hungary	496	4.2
Iceland	496	2.2
Ireland	513	3.2
Italy	478	3.1
Japan	550	5.5
Republic of Korea	552	2.7
Luxembourg	443	2.3
Mexico	422	3.2
New Zealand	528	2.4
Northern Ireland	523	3.5
Norway	500	2.8
Poland	483	5.1
Portugal	459	4.0
Scotland	**522**	**4.3**
Spain	491	3.0
Sweden	512	2.5
Switzerland	496	4.4
UK	**532**	**2.7**
USA	499	7.3
OECD total	*502*	*2.0*
Country average	*500*	*0.7*
Non-OECD Countries		
Brazil	375	3.3
Latvia	460	5.6
Liechtenstein	476	7.1
Russian Federation	460	4.7

Factors Associated with Student Performance

The following is based on the analysis of data from all of the countries that participated in PISA and the associations identified between different factors and student attainment may not pertain in the UK. However, they do provide interesting insights into what factors may be influential in particular circumstances.

Expenditure on Education

There is a positive association between adjusted national income (GDP) per capita and student attainment. This association suggests that 27% of the variation between countries' mean scores can be predicted on the basis of their GDP per capita. There is unlikely to be a direct causal relationship between GDP and student attainment but a more likely one would be between actual spend on education per student and student attainment. In fact this variable only explains about 17% of the variation between countries' mean performances. The figures suggest that spending alone is not sufficient to achieve high attainment.

School Related Factors

Engagement with School

In 21 of the 28 countries for which data are available, more than one quarter of students agreed or agreed strongly that school was a place they did not want to go to and the percentage of students saying this was as high as 44% in one country. In half of the OECD countries the majority of students also agreed or strongly agreed that school was a place where they felt bored. This suggests that disaffection with school at this age is common. This does matter as students with more positive views about school performed better on average on the combined reading literary scale than those who did not hold such views.

Student Related Factors Influencing the School Climate

Both the student and head teacher questionnaires included questions on the respondents' perception of factors that affect the schools' climate for learning. Head teachers identified student absenteeism as the most frequent obstacle to learning, 48% on average identifying this as hindering learning either to some extent or a lot. Disruptive behaviour was the next most frequently mentioned obstacle to learning, mentioned by 41% of head teachers, then students skipping classes mentioned by 33% and students lacking respect for teachers mentioned by 24%. Fourteen per cent indicated that students' intimidation or bullying of other students hindered learning to some extent or even a lot. The student related factors emphasise the importance of the Discipline Task Force's work on the causes of indiscipline and ways of dealing with it.

From students the most frequently mentioned problem influencing their learning was wasting time at the beginning of lessons, more than 5 minutes spent doing nothing reported by 40% of students. On average a third of students reported that the teacher had to wait a long time for students to quieten down in most or every lesson and that there was noise and disorder in their home language class. Fewer than 20% of students in the UK reported that students tended not to listen to what teachers say.

The Learning Environment

Teacher support for their students is known to have a beneficial effect on students' performance. In PISA students were asked about the teachers' interest in their progress and about whether teachers continue to teach until students understand. In the UK these questions were asked about students' English teachers.

On both these questions students rated UK teachers highly although there was considerable variation in the responses in other countries.

It is interesting to speculate about the relationship between teachers' support and student performance. If the encouragement offered by teachers is effective then it is reasonable to expect that this relationship will be positive. On the other hand if teacher support is targeted on particular groups (for example less able students) or on the classes in which they are placed, the relationship could be negative because of the detrimental effect on the other students.

In practice the relationship is mixed and generally weak, probably reflecting different practices in different countries. However, in those countries which value teacher support above the OECD average, the correlation between teacher support and student performance on the reading literacy scale tended to be positive and statistically significant. This applies to the UK but more research would be required to explore how this relationship arises.

In many countries head teachers' perceptions of school climate were related to students' performance. In particular, in the UK, Belgium, Germany, Hungary, Italy, Japan, Poland and the Netherlands the head teachers' index of student related factors affecting school climate explains between 12 and 18% of the variation in reading literacy performance. In these countries between 80 and 111 points separate the performance of students in schools where the head teachers' views fall in the top and bottom quarters on the index of factors affecting school climate. The relationship between students' views on factors affecting school climate and student performance in reading literacy tended to be weaker but was clearly visible in many countries. This exemplifies the importance of school ethos which has received considerable emphasis in Scotland in recent years through school self evaluation and the Ethos Network.

Using head teachers' responses to questions on their schools infrastructure and the quality of educational resources two indices were developed. Only in a few countries did some head teachers report that their schools' infrastructure hindered learning. In others, including the UK, head teachers were more concerned about educational resources such as computers, library and teaching materials, including text books and multimedia resources for learning. Educational resources were closely related to students' performance in the UK. The difference between the top and bottom quarters in terms of educational resources on the reading literacy scale was substantial (39 points).

In schools where head teachers reported, on average, a higher degree of autonomy student performance on the reading literacy scale tended to be better. This seems to support the case for devolved school management, which is well advanced in Scotland. Schools in which teachers were strongly involved in school management also performed better than others. There was a weaker but positive association between student performance and schools' budgetary autonomy.

Teaching Related Factors

Teacher Related Factors Affecting School Climate

Head teachers were asked about teacher related factors affecting school climate. The questions were whether they perceived learning in their schools to be hindered by low expectations of students by teachers, poor teacher-student relationships, absenteeism among teachers, staff resistance to change, teachers not meeting individual students' needs and students not being encouraged to achieve their full potential. In Scotland the regime of target setting for schools may help to influence the last of these. As would be expected in most countries the relationship between head teachers' perceptions of teacher related factors and student performance was positive, that is more positive views were related to higher performance. However, the relationship was, with few exceptions, not very strong.

Head teachers were also asked about teachers' morale and commitment by indicating how strongly they agreed or disagreed with statements such as "teachers work with enthusiasm", "teachers take a pride in this school" and "the morale of teachers in this school is high". The relationship between these perceptions and student performance tended to be modest and in the UK only explained just over 2% of the variation in reading literacy scores.

Competitive and Co-operative Learning

Separate indices for competitive and co-operative learning were created from students' responses. The competitive index was derived from questions about whether students like trying to do better than others, like being the best at something, work well when trying to be better than others and learn faster when trying to be better than others. The co-operative learning index was derived from questions about whether students like working with others, like helping others do well in a group, learn most when working with others and perform best when working with others. Both indices tended to be positively related to performance on the combined reading literacy scale although the relationship was more pronounced in the case of competitive learning. The differences in performance between the top and bottom quarters of the indices were 32 points for the competitive index and 22 points for the co-operative index. The results suggest that, if operated in tandem, both types of learning can add to learning effectiveness.

Learning Outside School

Those attempting to improve educational outcomes seek to increase or use more effectively the time students are engaged in learning activities. Most of this is done through manipulating the instruction time of students but homework policies and practices are another element. In many OECD countries homework constituted a major part of students' learning time. In PISA students were asked how much time they spent on homework in their home language, in mathematics and in science.

The results indicate that an average of 4.6 hours homework per week was done on these three subject areas ranging from 3.3 hours or less in Japan and Sweden to 5.8 hours in Greece and Hungary. This amounts to more than 30% of instruction time in schools in these subjects. In addition students reported attending additional or remedial courses outside their schools. For example, on average across all OECD countries 25% of students reported that in the last three years they sometimes or regularly attended extension or additional courses outside their school. In the case of Japan and Korea the figures were 64% and 71% respectively.

The relationship to student performance may not be straightforward for homework. Some teachers may assign more homework to students they think need to improve their performance. Slower learners may need more time to complete the same amount of homework. Students who report spending relatively little time on homework may either be able students who complete their homework quickly or disengaged students who do not wish to spend time on school related activities at home.

Despite these complexities the relationship between the time spent on homework in the three subject areas and student performance tended to be consistently positive. The homework index explained between 7 and 15% of the variation in reading literacy performance in the UK, Australia, Belgium, France, Greece, Italy, Hungary, Poland, Spain, the Russian Federation and the USA. The association between homework and student performance tended to be stronger in countries where the homework index was higher perhaps indicating that a certain level of homework has to be reached before it becomes effective. This finding supports the emphasis placed on homework and supported study in Scotland.

Computers as a Tool for Learning

The part of PISA dealing with computers was an international option in which 16 countries took part. In these countries 65% of students said they used a computer because they were very interested in computers. In no country was this percentage lower than 50%. Male students showed much stronger interest in computers than female students except in the USA where interest was equally shared. On average 69% of students said they were comfortable or very comfortable using a computer to write a paper and 56% to take a test on a computer.

An index was derived from various questions about students' interest in computers, such as whether it is important to work with a computer, that playing and working with a computer is fun, that they use a computer because they are very interested and they forget the time when they are working with a computer. Students with higher values in this index tended to perform better on the combined reading literacy scale. The interpretation of this relationship requires some caution, however, as not only is the direction of influence unclear but also there may be third factors in operation such as students from more affluent homes with greater access to computers having more interest in them.

Student Related Factors

Students' Subject Interests

The students' interest in reading was assessed with a number of questions in their questionnaire. These included ones to determine whether they thought reading was fun and whether they became totally absorbed in their reading. An index of interest in reading was derived from these questions and its relationship to reading literacy was analysed. About half of the students surveyed in PISA were generally positive about reading. The results also showed that interest in reading was not associated with different levels of reading literacy performance between countries, but there was an association between them within individual countries.

The index for interest in mathematics varied more than that for reading. As with interest in reading, interest in mathematics was not associated with differences in attainment between countries but it was with attainment within individual countries, although to a lesser extent than interest in reading.

Student Engagement with Reading

Students were asked how frequently they read for pleasure, whether they enjoyed talking about books and how frequently they visited libraries and bookshops. The results suggest much more needs to be done to foster positive engagement with reading. Forty four per cent of students reported reading only to obtain information they needed, more than a third that they read only if they had to and 22% agreed or agreed strongly with the statement "reading is a waste of time". The index of engagement with reading was positively associated with reading literacy attainment in virtually every country, with greater performance in all but 6 countries of one proficiency level between the bottom and top quarters of the engagement in reading index.

Time Spent Reading for Enjoyment

Students were asked about the time they spent reading for enjoyment. On average over all OECD countries 32% of students said they did not read for enjoyment at all. The performance in reading literacy of students varied substantially with the amount of time they read for enjoyment – more time, higher scores – indicating the need to provide an environment that encourages reading outside of school.

Gender Differences in Performance

In the last major international study looking at performance in mathematics and science, the IEA Third International Mathematics and Science Study (1995), there were few statistically significant gender differences at age 9 and these were all in favour of male students. At age 13 there were more significant gender differences again in favour of male students. This suggested that gender differences were more pronounced and pervasive at higher grade levels.

In PISA the different subject areas produced different patterns of gender differences. In reading literacy female students reached significantly higher levels of performance than male students with the greatest difference (45 points) being on the reflection and evaluation scale. The next greatest difference was on the interpretation scale (29 points) and the difference was least on the retrieving information scale (24 points). This superior performance from female students was therefore not only universal but was also large. In all OECD countries males were more likely than females to be among the lowest performing pupils, the ratio of males to females performing at levels 1 or 2 in the combined reading literacy ranging from 1:1.3 to 1:3.5 in different countries.

In mathematical literacy there were statistically significant differences in the performance of male and female students in about half of the countries which participated in PISA, all in favour of male students. However, the average gender difference (11 points) was only about one third of that in reading where it was in favour of female students. The advantage for male students was mainly due to high levels of performance of a comparatively small number of male students. The proportion of male and female students performing at the lowest levels was roughly equal.

In scientific literacy there was no clear pattern of gender differences. The gender differences in science at age 13 in the Third International Mathematics and Science Study were much larger, almost always favouring male students. The difference between the Third International Mathematics and Science Study and PISA may be explained in part by the fact that the PISA assessment of scientific literacy placed greater emphasis on life sciences in which female students tend to perform well. PISA also had a higher proportion of open-ended and contextualised tasks in which female students tend to do better, rather than the multiple choice tasks favoured by male students.

The significant variation in gender differences between countries, between students' ages (in past studies) and between subjects indicates that policies and practices can reduce gender differences. There is, therefore, a need for attention to be given to the under performance of male students in reading literacy in Scotland.

Gender Differences in Subject Interest

Female students tended to express greater interest in reading than male students, whereas the opposite was true in mathematics. This was also true for engagement in reading, attitudes towards reading and time spent reading. In general female students were more likely to read more demanding texts. Gender differences in performance in reading literacy and mathematical literacy were closely mirrored in student interest in the respective subject areas and this relationship held true in all countries which participated in PISA. However, the nature of this relationship may well be complex in that interest and performance probably reinforce one another but it does reveal inequalities between the genders in the effectiveness with which schools and societies promote motivation and interest in different subject areas.

Gender Differences, Learning Strategies and Self Concept

In the majority of countries female students reported emphasising memorisation strategies more than male students. Male students tended to use elaboration strategies more often than female students. In countries with significant gender differences, female students were also more likely to adopt a self evaluation perspective during the learning process which has implications for recording student progress. These differences may indicate ways of tackling the problem of gender inequality.

There is evidence that individuals' beliefs about themselves were strongly related to successful learning and this was confirmed by the PISA results. Female students expressed greater confidence about their performance in reading than male students and in mathematics males tended to have a higher self concept than female students.

Home Related Factors

Family Background and Student Performance

Students come from a variety of family backgrounds and schools need to provide for a very diverse student body in this respect. The learning environment can be enhanced by this variety of backgrounds. However, the variation in student ability increases the challenges that schools face. To investigate this PISA developed a socio-economic index based on the occupations of students' parents.

Differences in socio-economic status were associated with large differences in student performance. In the UK the difference between students in the top and bottom quarters of the socio-economic index were well above the equivalent of one proficiency level on the reading literacy scale. Students who were in the bottom quarter of the socio-economic index

scale were more than twice as likely as other students to be among the bottom 25% of the UK's students on the reading literacy scale. The development of New Community Schools should impact on the problems of poverty and deprivation and thus help to improve these students' performance.

Family wealth was also considered in PISA and found to have a similar but less pronounced relationship than parental occupation to students' performance. The largest differences in performance between students in the top and bottom quarters of family wealth were found in the USA (85 points) whereas in Finland (in reading literacy) and Japan (in mathematical and scientific literacy) students in the bottom quarter for family wealth had high scores.

Communication in the Home

Parental support for their children's education is widely seen as an essential element in their success at school. PISA asked students to indicate how often their parents communicated with them to discuss political or social issues, books, films or TV programmes and how well they were doing at school, when they were eating their main meal and when spending time just talking. The responses were used to construct two indices, from the first three questions one of cultural communication and from the second three one of social communication.

On both indices more frequent communication was associated with higher average scores on the combined reading literacy scale but the association was stronger for cultural communication. This indicates that communication between parents and students is of educational benefit and that measures to increase this communication should be encouraged. This is one aspect of the Early Intervention initiative which should continue to receive attention.

Parental Education

PISA gathered information on their mothers' occupations from the students. This showed that students whose mothers had completed upper secondary education achieved higher levels of performance in reading literacy and that in most countries mothers' completion of tertiary education gave a further, if lesser, advantage. However, although this trend holds good in all countries students' performance levels vary between them. For instance, in Australia, Finland and Korea students with the least educated mothers have mean scores above the mean score for students in all OECD countries.

Family Structure

Students participating in PISA provided information about who usually lived at home with them. The results indicated that overall about 15% of students were in one parent families and this was over 20% in the UK. Overall there was a 12 point difference in performance on the reading literacy scale to the disadvantage of students from single parent families compared to other students, a difference which was over 28 points in the Netherlands, UK and the USA. It seems there is an issue about how to facilitate productive home support for children's learning which does not demand more time and resources than single parents can supply if the performance of these students is to be improved.

Activities Related to Culture

PISA asked students about possessions related to classical culture in their homes, for instance whether their homes contained classic literature, books of poetry or works of art. Such possessions were related to student performance in reading literacy and to a lesser extent in mathematical and scientific literacy. The lack of such possessions is of course

relative and students with few possessions in one country may perform better than pupils with more possessions in another country. Students with the highest levels of cultural possessions, who tended to have higher socio-economic home settings, typically did exceptionally well in PISA. In the UK the average scores for students in the top quarter of cultural possessions exceeded 560 points in reading, mathematical and scientific literacy compared to mean scores of 523 points, 529 points and 532 points respectively.

It does not appear to be the case that the kind of cultural activities on which school curricula often build make a difference to student performance. However, the effects of cultural possessions emphasise that there is benefit in home based access to literature and art.

Conclusions

Although there are differences in the participating countries and in the timing of studies, the PISA results indicate that Scotland's 15 year olds performed significantly better in terms of attainment in mathematics and science than our 9 and 13 year olds did in 1995. As PISA results are similar for reading it seems likely this is also the case for performance in reading.

Scotland was in the top third of OECD countries in all subjects assessed in PISA. Gender differences in student performance were quite low in Scotland with the exception of reading literacy where female students performed much better than male students.

PISA looked for associations between different factors and different levels of student performance. These factors included expenditure on education, school related factors, teaching related factors, student related factors and home related factors. The outcomes of this analysis are illuminating:

- **_Expenditure on education_**

  Much of the variation in student performance between countries was related to per capita GDP. This relationship is not a direct one but will operate through intermediate variables such as better schools, professionally trained teachers and students from more affluent home backgrounds. Interestingly the actual spend on education in countries has a weaker relationship to student performance, perhaps indicating that better schools and better equipment and resources are less important than other factors.

- **_School related factors_**

  More than a quarter of students said school was a place they did not wish to go to and the majority of students said school was a place where they felt bored. These responses indicate that efforts need to be made to convince students of the value of their education and to make the school environment a more attractive one for students. This is important as students with more positive views on school performed better in reading literacy.

  Head teachers believed that student absenteeism, students' disruptive behaviour and students skipping classes were the main obstacles to learning. Students thought the main obstacle was wasting time at the beginning of lessons while students quieten down. These views are important, as student performance was better in schools where more positive views were held. Clearly the work of the Discipline Task Force will be important in this context.

  Students were asked about the support they received from their teachers. Overall this type of support was only weakly related to student performance but in those countries with a higher rating on teacher support the relationship was stronger and significant. It does appear that teachers should be encouraged to continue to provide adequate support for all their students.

  Both head teachers and students were asked about the climate in their schools. The views of head teachers were related to student performance on the reading literacy scale, the students' views less so. School climate does seem to be important and measures should be taken to ensure a supportive and encouraging climate exists in every school. The work that continues to be done on improving the ethos of schools is clearly important.

  Questions were asked in PISA about schools' infrastructure and their educational resources. The former was not found to be related to school performance but the latter was. Clearly the provision of good educational resources to schools is a significant factor in promoting learning.

  The performance of students on the reading literacy scale is higher in schools which have greater autonomy and where teachers are involved with school management. Budgetary autonomy is also positively related to student performance but to a more limited extent. There does seem to be support here for the principle of devolved school management.

- **_Teaching related factors_**

  Head teachers were asked various questions about teachers' morale and relationships with pupils. More positive responses were associated with better student performance but the relationship was a relatively weak one. These findings indicate that these teacher related factors only influence learning to a limited extent.

The relative effectiveness of competitive and co-operative learning approaches was investigated. The results indicated that both styles of learning were positively related to student performance which suggests that both should be used as opportunities arise. Advice has been issued by HMIE on the need to use a variety of teaching approaches to meet the learning needs of all students.

The relationship between homework and student performance tended to be consistently positive. However, the relationship was stronger in countries where more homework was set for students. This may indicate that a certain threshold of time has to be invested in homework before it becomes fully effective. It appears that the encouragement given in Scotland to homework and supported study has been well directed.

Computers are increasingly being used in school by both teachers and students to enhance learning. The PISA results indicated that there was a high level of student interest in computers, more among male students than among female students, and a majority of students was comfortable using computers. Reading literacy scores were higher for those students most interested and comfortable with computer use, although this may in part be due to other factors, such as more affluent homes providing greater access to computers. However, the findings do suggest that current developments in the provision and use of computers in schools will have a beneficial influence on teaching and learning.

- ### *Student Related Factors*

About half of students held positive views about reading and students' interest in reading was associated with better reading literacy performance within countries but not between countries. Interest in mathematics was more varied and was not associated so strongly with students' attainment in mathematics. The time spent by students reading for enjoyment was quite low and almost a third of students said they did none at all. However, time spent reading for enjoyment was positively related to students' performance. This indicates that there is a need to encourage a positive environment with respect to reading for enjoyment as a means of improving reading skills.

In PISA there were differences in performance related to the gender of students. Comparison of the findings with earlier studies seems to indicate that these differences increase as students progress through their education. In PISA female students performed consistently better in reading literacy to a substantial extent. As reading skills are a prerequisite to learning in all subjects the apparent under performance of male students is a cause for concern. In mathematics male students tend to perform better than female students but to a more limited extent. The position in science is less clear cut as there were few significant differences between male and female students. The gender differences in performance between subjects and between countries indicate that different policies and practices could reduce gender related inequalities.

- ***Home related factors***

The socio-economic background of students had a major influence on their school attainment. In the UK students in the top and bottom quarters of the socio-economic index differed in performance by more than a proficiency level on the reading literacy scale. Students in the bottom quarter of the socio-economic index were more than twice as likely as other students to be in the bottom 25% on the reading literacy scale. Family wealth was also related to student performance but the relationship was less pronounced. Clearly there is a continuing need to tackle the problems of poverty and deprivation.

In PISA students were asked how frequently their parents communicated with them in a range of different contexts. The responses were used to construct two indices - one of cultural communication and the other of social communication. Both indices were related to student performance on the reading literacy scale although the relationship was stronger for cultural communication. There is a need to encourage these types of parent-student communication to assist in the development of language skills.

Information on their mothers' education was gathered from students. This was found to be related to students' performance on the reading literacy scale particularly for mothers who had completed upper secondary education. As the education of parents increases this is likely to impact positively on the attainment of their children.

In PISA students were asked who lived at home with them as a guide to family structure. About 20% of UK students came from one parent families which analysis showed put their children at a disadvantage in terms of attainment. There is a need to seek ways to facilitate productive home support for children's learning which does not demand more time and effort than single parents can provide.

In PISA students were asked about the possessions in their homes related to classical culture such as books, poetry and art. Such possessions were positively related to students' performance. This relationship is likely to be at least in part due to socio-economic factors. These cultural possessions in the home cannot be equated with the kind of cultural activities on which school curricula are based.

References

1 *Second International Assessment of Educational Progress. Mathematics and Science Around the World. A Scottish Perspective,* Research and Intelligence Unit, The Scottish Office Education Department, 1992.

2 *Achievements of Primary 4 and Primary 5 Pupils in Mathematics and Science,* The Scottish Office Education and Industry Department, 1997.

3 *Achievements of Secondary 1 and Secondary 2 Pupils in Mathematics and Science,* The Scottish Office Education and Industry Department, 1997.

4 *Assessment of Practical Skills in Mathematics and Science,* The Scottish Office Education and Industry Department, 1997.