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# Some Aspects Related to Digital Reading Proficiency

Education systems are increasingly incorporating information and communication technologies into their teaching practices. This chapter examines the student- and school-related factors that are most strongly associated with digital reading proficiency, including the use of a computer at home and at school, students' engagement in online reading activities, students' learning strategies, students' attitudes towards reading, the socio-economic background of the school and the student, and gender.

In recent years some education systems have begun to emphasise the use of digital technologies to communicate with parents and students, submit students' work to teachers, present concepts to students, search information on the Internet, report results to students, and deliver assessments. The latter is of most direct importance to PISA.

While countries have been administering paper-based PISA tests since 2000, there have been two significant computer-based components: the computer-based assessment of science as part of PISA 2006 and the digital reading assessment as part of PISA 2009 (as described in this volume). For PISA 2012 and 2015, a much larger number of test components is expected to be computer-based, and many more countries will participate in these assessments.

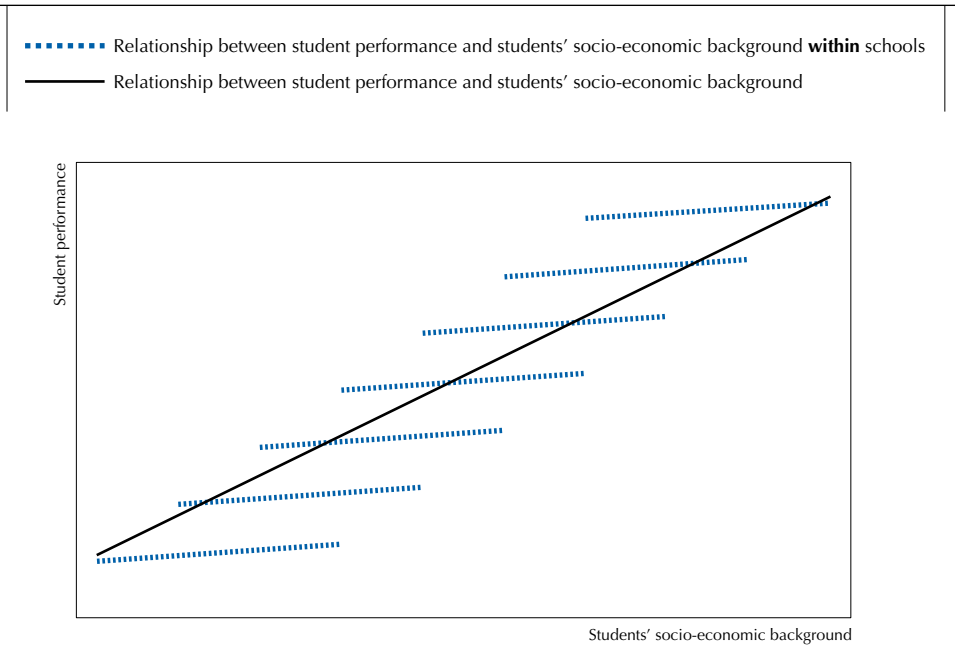
A comparison of countries' results in paper-based and computer-based assessments, and the aspects that affect them, is therefore valuable. This chapter presents an analysis of the combined influence of a range of variables discussed in the previous chapters on digital reading proficiency. A multivariate analysis investigates how gender, print reading performance, use of a computer, reading engagement and selected socio-cultural variables are associated with digital reading performance. The interplay between student- and school-level variables is also analysed in a multilevel estimation of what is related to students' performance in digital reading. Background information is drawn from the student, school and ICT familiarity questionnaires.

Chapter 4 mainly examines relationships between individual student characteristics and digital reading performance. These characteristics are considered again here, but the context of school characteristics is also included in the analysis. The use of such multilevel regression models (Bryk and Raudenbusch, 1992) has a number of advantages over single-level regression models. It takes into account the fact that students are grouped within schools. The relative contribution of the school can be considered when estimating the contribution of each aspect to student performance.

Consider the example of socio-economic background across and within schools. Figure VI.7.1 shows a hypothetical relationship between socio-economic background and student performance in a number of different schools within a fictional country. The single black line in the figure represents the country's average socio-economic gradient across all students – that is, the association between students' socio-economic background and performance.

■ Figure VI.7.1 ■

**Illustration of the relationship between students' socio-economic background and student performance**




Source: OECD, *PISA 2009 Database*.
StatLink http://dx.doi.org/10.1787/888932435473

The blue dotted lines in the figure represent the within-school socio-economic gradients – that is, the association between students' socio-economic background and performance within the individual schools that make up the sample (for simplicity's sake, the gradient in each of the schools is assumed to be the same, although this is not necessarily the case). The graph shows three main points:

1. Schools differ in the socio-economic background of their students: the schools to the left have more disadvantaged students than the schools to the right.
2. Schools differ in the performance of their students: the schools at the bottom of the graph show lower student scores, on average, than the schools at the top.
3. The socio-economic gradient within individual schools is much less steep than the overall socio-economic gradient across all schools.

Therefore, while it may be said that this country has a steep socio-economic gradient, the impact of socio-economic background within schools is not so great.

The analysis in this chapter includes the 19 countries and economies that took part in the digital reading assessment, except when using the ICT familiarity questionnaire. In those instances, the analysis involves the 17 countries and economies that took part in both the digital reading and the ICT familiarity questionnaires.

## VARIATION IN STUDENT READING PERFORMANCE

Countries show differences in the amount of variation between high-performing and low-performing students. The first three columns of Tables VI.7.1a and VI.7.2a show the within-school variation, the between-school variation and the total variation in student performance in digital reading. These tables show that in some countries there is relatively small variation between students while in other countries the variation is relatively large. For example, the total variation in Austria is larger than it is in Korea.

Column 4 of Table VI.7.1a and Table VI.7.1b shows the proportion of between-school variation compared to total variation (called the intra-class correlation), which gives an indication of the similarities and differences among schools in a given country. A high intra-class correlation indicates large differences between schools, meaning that parents will need to be cautious in choosing the most appropriate schools for their children. A low intra-class correlation indicates a country in which schools perform more consistently.

On average across the OECD countries for which data are available, the intra-class correlation for digital reading is 36.6%. In some countries the intra-class correlation is quite high, indicating large differences between schools in digital reading performance. For example, in Austria the value is 66.7% and in Hungary it is 65.6%.

These differences in variation may be associated with aspects related to student background and attitudes towards school, and to policies and practices in the different countries' education systems. This chapter aims to explore the relationship between school and student characteristics and performance in the PISA 2009 digital reading assessment. A model, based on multilevel regression models (student and school levels),[1] was designed to investigate the relationship between school and student features and performance, while taking other aspects into account. Previous chapters show that there is a strong link between digital and print reading proficiency. The model presented in this chapter is in two forms: in the first, important aspects associated with digital reading proficiency are examined without taking the students' print reading performance into account; in the second, print reading proficiency is taken into account. This is done in an attempt to isolate the aspects that are more directly associated with digital reading proficiency.

## SOCIO-ECONOMIC ASPECTS

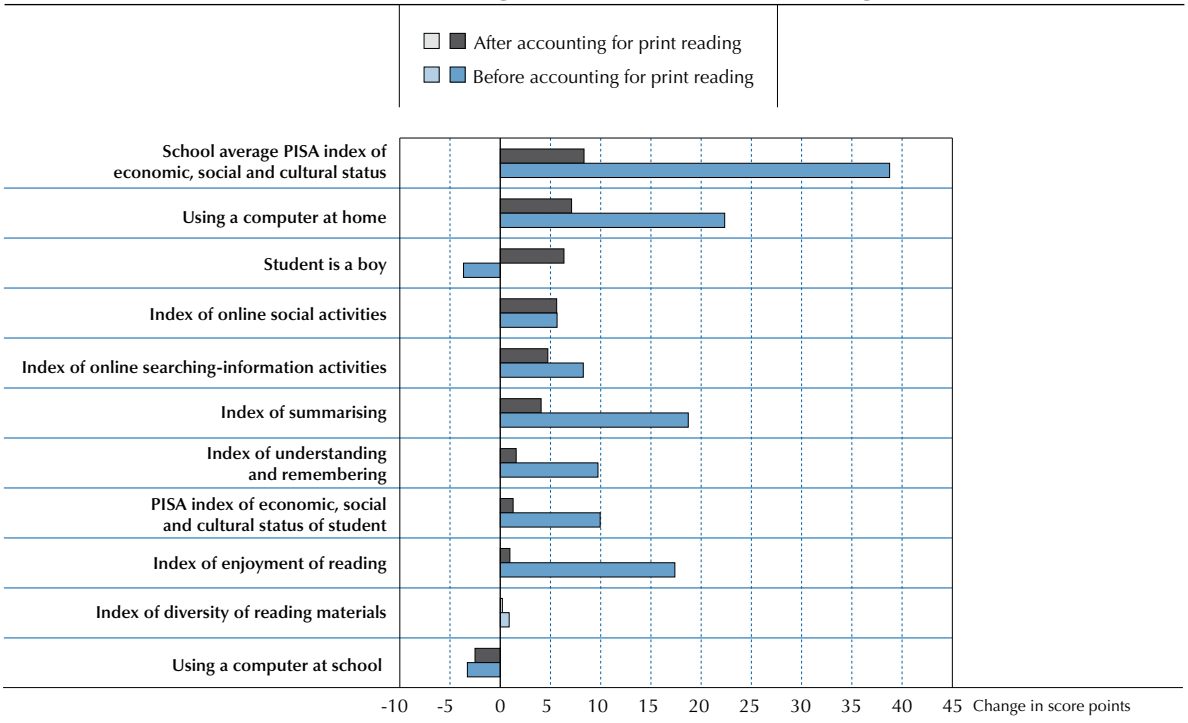
### Student socio-economic background

Figure VI.7.2 shows the relationship between digital reading performance and each of the variables before and after students' print reading scores are taken into account.

Student socio-economic background is indicated by the *PISA index of economic, social and cultural status*, which includes measures of parents' education and occupation and cultural possessions found at home.

■ Figure VI.7.2 ■

**Score point differences in digital reading associated with variables in the multilevel regression models, OECD average-15**




Note: Changes in score that are statistically significant are marked in a darker tone.
*Bars are ranked in descending order of the change in digital reading score after accounting for print reading.*
Source: OECD, *PISA 2009 Database,* Tables VI.7.1b and VI.7.2b.
StatLink http://dx.doi.org/10.1787/888932435473

Across OECD countries, a change of one unit in this index is associated with a 9.9 score point difference before print reading is taken into account, and a 1.3 score point difference after taking print reading into account. The relationship between student socio-economic background and digital reading performance is largest in Poland, at 19.0 score points before taking print reading into account and 6.2 score points after (Tables VI.7.1b and VI.7.2b).

### Mean school socio-economic background

Volume II, *PISA 2009 Results: Overcoming Social Background: Equity in Learning Opportunities and Outcomes,* shows that the combined impact of some student variables is greater than the impact of individual variables. The mean school socio-economic background is the average of the students' *index of economic, social and cultural status* at a school. As can be seen in Figure VI.7.2, this variable has a great impact on digital reading performance, with a 38.8 score point difference associated with a one standard deviation change in the index across OECD countries. In four countries this impact is over 63 score points: Belgium (69.5), Austria (69.0), Hungary (65.0) and Japan (63.1). After taking print reading into account, the difference is still an average of 8.3 score points across OECD countries for each unit of change, but this is not statistically significant in over half of OECD countries. Caution is required in interpreting the results of average school socio-economic background, since it is often highly related to other school-level variables, such as school type, location, level of educational resources, school size, etc., in a way that student socio-economic background is not.

## ATTITUDES TOWARDS READING

### Enjoyment of reading

Chapter 4 shows that enjoyment of reading is one of the variables significantly associated with student performance in both digital and print reading. This result is confirmed in the two-level model.

Without taking students' print reading proficiency into account, a one unit change in the *index of enjoyment of reading* is associated with a change of 17.4 score points in digital reading, on average across OECD countries. The impact is over 20 score points in New Zealand (26.0 score points), Denmark (22.8), Australia (21.5), Iceland (20.8) and Ireland (20.1) (Table VI.7.1b).

After taking print reading into account, there is a 1.0 score point difference across OECD countries. The countries with the greatest association between enjoyment of reading and digital reading proficiency are Chile (5.0 score points), Denmark (4.0 score points) and Japan (3.1 score points) (Table VI.7.2b).

### Diversity of reading materials

The diversity of reading materials has a relatively small association with students' digital reading proficiency, both before and after print reading proficiency is taken into account. On average across the participating OECD countries there is a 0.9 score point difference associated with a change of one standard deviation in the index, before print reading is taken into account (Table VI.7.1b).

In three countries the association is negative. For example, in New Zealand there is a decrease of 10.9 score points for every one standard deviation increase in the *index of the diversity of reading materials*; in Australia (-5.5 score points) and Iceland (-4.0) the association is also negative. The largest positive association was found in Sweden (7.9 score points), Norway (6.6), Spain (5.4) and the partner economy Macao-China (6.4).

After print reading is taken into account, the average for participating OECD countries is only 0.2 score point (Table VI.7.2b).

## USE OF COMPUTERS

The use of computers at home and at school is discussed in Chapter 5 and its relationship to performance in Chapter 6. This chapter considers the impact of these two aspects when taking other variables into account.

### Computer use at home

Students responded to questions on the ICT familiarity questionnaire on whether they use computers, including both desktop and laptop computers, at home. Figure VI.7.2 shows that computer use at home has a positive relationship on digital reading proficiency, both before and after print reading proficiency is taken into account.

Across OECD countries, there was an average 22.3 score point difference in digital reading performance between students who reported that they use computers at home and students who reported that they do not. The difference is largest in Norway (47.0 score points), Sweden (39.7 score points), Belgium (38.8 score points) and the partner economy Hong Kong-China (33.5 score points) (Table VI.7.1b).

After taking into account students' print reading proficiency, the average across OECD countries is 7.1 score points, with the largest impact seen in Belgium (20.7 score points), Sweden (18.0), Japan (13.5) and the partner economy Hong Kong-China (19.0) (Table VI.7.2b).

### Computer use at school

Students also responded to questions on the ICT familiarity questionnaire on whether they use computers, including both desktop and laptop computers, at school.

Before taking into account students' print reading proficiency, students who reported that they use computers at school perform 3.3 score points lower in digital reading than students who reported that they do not use computers at school, on average across OECD countries. The relationship is most negative in Hungary (-13.9 score points) and the partner economy Hong Kong-China (-11.2 score points) (Table VI.7.1b).

After taking print reading proficiency into account, the score point difference associated with computer use at school is smaller (-2.5 score points), but it is still negative across OECD countries (Table VI.7.2b).

## ONLINE READING PRACTICES

All students participating in PISA 2009 responded to questions in the student questionnaire about how they use computers. Chapter 4 describes how further analysis of this area reveals two main areas of activity.

The first centres on searching for information, such as reading news, using a dictionary, searching online information to learn about a particular topic, and searching for practical information on line. The second centres on social activities: reading e-mails and chatting on line.[2]

While the *index of online reading activities* appears in the PISA 2009 database, the *index of online searching-information activities* and the *index of online social activities* do not.

### Searching-information activities

The aspect relating to information-gathering has a positive association with student performance in digital reading. This is indicated by an average difference of 8.3 score points associated with a one standard deviation change in the index. This association was over 12 points in Japan (12.5 score points), Korea (12.3) and Iceland (12.2) (Table VI.7.1b). After taking into account students' print reading proficiency, Japan (9.1 score points) and Korea (8.0) are still the countries with the greatest association between information-gathering and digital reading proficiency (Table VI.7.2b).

### Social activities

The less academically-focused use of the computer for social activities resulted in a weaker association with student performance than searching-information activities. On average across OECD countries, the association with digital reading proficiency was 5.7 score points before taking account of print reading proficiency, and 5.6 score points after (Tables VI.7.2a and VI.7.2b).

## LEARNING STRATEGIES

Students employ different techniques and processes to help them to learn. The PISA 2009 student questionnaire included a number of questions to find out which strategies students prefer and which strategies are effective (see Chapter 4 for full details).

### Awareness of strategies to understand and remember information

Student responses were matched to expert opinions about the best strategies to understand and remember information.

Knowledge of these strategies is positively related to digital reading, with an average association in the participating OECD countries of 9.7 score points before taking account of print reading. The association was largest in Denmark (14.1 score points), Iceland (13.8), Chile (12.5) and New Zealand (12.2) (Table VI.7.1b).

After taking print reading into account, the average of the participating OECD countries is 1.6 score points (Table VI.7.2b).

### Awareness of effective strategies to summarise information

The questionnaire also sought responses from students regarding their views on the most effective strategies to summarise information. Their responses were compared to expert opinions and a score was allocated.

Knowledge of these strategies is more strongly associated with performance in digital reading than the strategies to understand and remember information. Across participating OECD countries, this aspect is associated with an increase of 18.7 score points in digital reading proficiency, before taking print reading proficiency into account (Table VI.7.1b). The increase is larger than 20 score points in Poland (24.9 score points), Ireland (24.2), Spain (23.8), Denmark (22.8) and Norway (21.0).

After students' print reading proficiency is taken into account, knowledge of these strategies is associated with a 4.1 score point difference in digital reading proficiency across participating OECD countries (Table VI.7.2b).

## GENDER

In all PISA surveys, girls have consistently outperformed boys in print reading in nearly every country. After taking the other aspects in the model into account, Table VI.7.1b shows that girls score an average of 3.7 points higher than boys in digital reading across OECD countries. In nearly all OECD countries, the result is in favour of girls or there is no score point difference between girls and boys. The only exceptions are Denmark, where boys outperform girls by

16.7 points, and Austria, where the difference is 15.4 score points. In the partner economy Hong Kong-China, boys outperform girls by 8.5 points. The largest gender differences in favour of girls are seen in New Zealand (16.6 score points), Iceland (12.0), Korea (11.2) and Norway (10.3).

When print reading performance is taken into account, the situation is different: boys have an average advantage of 6.3 score points over girls. This means that when we compare boys and girls who have similar levels of print reading proficiency, boys tend to perform better than girls in digital reading.

## VARIATION EXPLAINED BY THE MODEL

Columns 8, 9 and 10 in Tables VI.7.1a and VI.7.2a show the amounts of variation in student performance in digital reading that are explained by the two models. The columns show the within-school variation explained, the between-school variation explained, and the total variation explained, respectively. Before taking into account student proficiency in print reading, the model explains 28.5% of the within-school variation in digital reading performance and 58.0% of the between-school variation. On average across OECD countries, 41.6% of the total variation in student performance is explained by the variables in the model. The model explains around 50% or more of the total student variation in digital reading performance in Chile (57.8%), Japan (49.7%), Hungary (54.3%) and (Table VI.7.1a).

When students' print reading proficiency is included in the model, the explained within-school variation jumps to 72.3%, as would be expected, given the close correlation between students' print and digital reading proficiency. The model explains around 80% of the within-school variation in Sweden (80.9%) and Poland (79.1%) (Table VI.7.2a).

The amount of between-school variation explained by the model that includes print reading proficiency is 70.2%. The model explains over 85% of the between-school variation in Japan (93.0%), Chile (92.8%), Hungary (89.3%), Belgium (87.0%) and the partner economy Macao-China (89.4%).

Some 74.4% of the total variation in digital reading performance is explained by the model that includes student proficiency in print reading, on average across OECD countries. The figure is largest in Chile (81.5%), Belgium (80.5%) and Hungary (80.0%).

Thus, including print reading proficiency in the model increases the amount of explained variation, indicating that proficiencies in the two modes of reading are based on similar, but not identical, skills.

## CONCLUSIONS

As education systems increasingly incorporate computers and related information technologies into pedagogical processes, educators and policy makers need to know which activities and policies will lead to the most effective learning.

Figure VI.7.2 shows the aspects that have the greatest impact on student performance in the digital reading assessment. The schools' average socio-economic background is highly associated with performance. This holds true even when students' print reading proficiency is taken into account.

There is also a large score point difference associated with students' use of a computer at home. When taking the other aspects into account, there is an average score advantage of 22.3 points for students who use computers at home. After taking students' proficiency in print reading into account, students' use of a home computer remains an important aspect that affects digital reading performance. This means that students' use of a computer at home is not only related to better digital reading performance, but it also explains the performance difference between print and digital reading. In other words, when comparing two students who have similar levels of print reading proficiency (and have similar characteristics in all other aspects included in the model, including socio-economic background), the student who uses a computer at home tends to perform better in digital reading than the student who does not use a computer at home. The *index of summarising* also appears to be important for both digital reading performance and for explaining the performance difference between print and digital reading.

The *index of online social activities* and the *index of online searching-information activities* also explain the difference in performance between print and digital reading. When students tend to engage in more social activities and searching-information activities on line, they tend to perform better in digital reading than students who do not, even when all of these students are similarly proficient in print reading.

In contrast, the *index of understanding and remembering*, students' socio-economic background, and the *index of enjoyment of reading* are related to digital reading performance, but they do not have a great impact on the difference in performance between print and digital reading.

The relationship between gender and digital reading performance, before and after taking print reading into account, is also of interest. In line with all previous PISA results, girls score significantly higher in digital reading proficiency, before taking print reading into account. However, when comparing girls and boys who are similarly proficient in print reading, boys score significantly higher than girls.

## Notes

1. The model is of the form:

   $y = intercept + v1 + v2 + v3 + \ldots$.

   Where y is the dependent variable – in this case, performance in score points in digital reading – and v1, v2, v3, etc., are the score point differences associated with a one unit change in the variable (a change of one standard deviation in the relevant index). Thus, a positive value for the variable indicates an improvement in student performance associated with that variable when the effects of all the other variables have been taken into account. The variables may be school aspects, such as the average school socio-economic background, or student aspects, such as enjoyment of reading. The combination of these two types of variables (school and student) is why the model is regarded as a two-level model.

   Apart from two indices – *online searching-information activities* and *online social activities* – all variables are in the PISA 2009 database or can be constructed using the database. These two indices are the result of a division into two of the *index of online reading activities* (Annex A1a for the detailed description of the indices). The change in performance related to each of the variables, except computer use at home and school and gender, is indicated by the change in score points associated with a one unit change in the index. A number of different criteria contributed to the selection of the variables included in the model. A large number of variables were included in various trial forms of the model; some were retained while others were discarded. Parsimony invites researchers to not maintain independent variables that do not contribute at all to explaining changes in the dependent variable. It has been found that adding many non-contributing variables can decrease the statistical power of the model. In addition, if a variable was found to behave inconsistently in a few countries, the variable was removed from the model. Experience from previous PISA surveys was also tapped in the decision-making process, and the following sets of variables were included in the model: students' socio-economic background and gender; schools' socio-economic background; students' attitudes towards reading; students' use of computer at home and school; students' engagement in online reading activities; and students' meta-cognitive strategies for learning.

2. The variable "taking part in online group discussions or forums" has not been included in these analyses because it loaded equally on both factors.