6

Students' Use of Information and Communication Technologies and their Performance in Digital Reading

This chapter focuses on the relationship between students' familiarity with ICT and their performance in digital reading. It discusses students' access to and use of computers, both at home and at school, and analyses how the frequency of ICT use for various purposes – both leisure- and schoolwork-related – is associated with digital reading proficiency. The chapter also examines the relationship between students' self-confidence in using computers and their mastery of digital texts.

This chapter examines how students' performance in digital reading is related to their access to and use of computers. Chapter 4 examines the relationship between online reading activities and reading performance. This chapter extends the analyses in Chapter 4 by including a wider range of ICT-related activities drawn from the optional PISA 2009 questionnaire on ICT familiarity (see Chapter 5), and by differentiating where students use ICT – at home or at school. The analysis also includes students' self-confidence in working on high-level ICT tasks. The relationship between students' self-confidence and performance in digital reading, as well the relationship between students' self-confidence and different types of ICT activities, are examined. When students use computers more frequently, do they perform better in digital reading? Do students who have greater self-confidence in using computers perform better? When students use computers more frequently, are they more self-confident in using computers?

The chapter first examines the relationship between performance in digital reading and students' access to and use of computers at home and at school. It then analyses in more detail how the frequency of ICT use for various purposes is related to digital reading. This is followed by an in-depth study focusing on a subset of ICT activities to examine how these activities are related to digital reading, after accounting for students' reading proficiency. The last section examines how students' self-confidence in using computers is related to their performance in digital reading, and how ICT activities are related to students' self-confidence in using computers. These analyses, most of which are based on responses from the 17 countries that administered both the optional questionnaire and the digital reading assessment, do not attempt to show a causal relationship between any of these factors and performance.

The main focus of this chapter is on the bivariate relationship between students' familiarity with ICT and their performance in digital reading. More comprehensive analyses, examining the relationship between a wider range of student and school characteristics and performance in digital reading, are presented in Chapter 7.

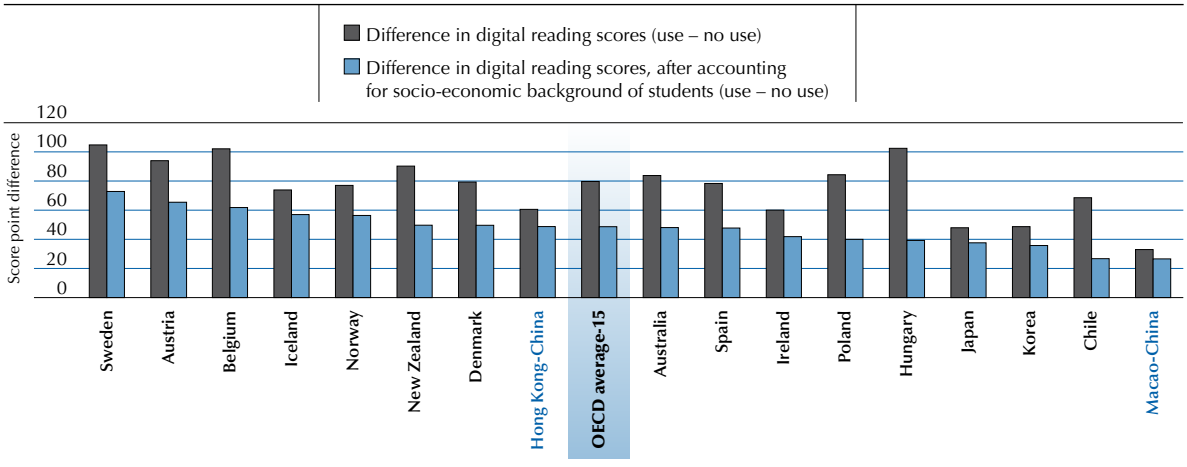
ACCESS TO AND USE OF COMPUTERS AND PERFORMANCE

Access to and use of computers at home

Chapter 5 shows that access to a computer at home has grown greatly over the past nine years. In PISA 2009, around 94% of students across OECD countries reported that they have at least one computer at home (Table VI.5.2). In all 19 countries and economies that participated in the assessment of digital reading, students who reported having a computer at home performed better than students who reported having no computer at home. Since in most countries students without a computer at home tend to be those from socio-economically disadvantaged backgrounds, the performance difference decreases in all countries and economies after accounting for students' backgrounds. Indeed, after accounting for students' socio-economic backgrounds, students who do and who do not have access to computers at home perform at similar levels in Korea, Austria and Sweden (Table VI.6.1).

■ Figure VI.6.1 ■

Difference in digital reading scores between students who use a computer at home and those who do not



Note: All differences in digital reading scores are statistically significant.
Countries are ranked in descending order of the performance difference after accounting for socio-economic background of students.
Source: OECD, *PISA 2009 Database,* Table VI.6.2.
StatLink http://dx.doi.org/10.1787/888932435454

Even if there is a computer at home, students may or may not be allowed to use it or students may or may not want to use it. The information on whether students use computers at home, including both desktop and laptop computers, is available in 45 countries and economies that administered the optional questionnaire on familiarity with ICT. Among these countries and economies, 17 also administered the assessment of digital reading. In all of these 17 countries and economies, students who reported using computers at home tend to perform better than other students, including both those who reported that they do not use computers and those who reported that there is no computer available at home (Table VI.6.2). In Sweden, Hungary and Belgium, students who use computers at home score at least 100 score points higher than students who do not, as shown in Figure VI.6.1.

Since socio-economically advantaged students are more likely to use a computer at home than disadvantaged students, the performance advantage among students who use a computer at home tends to be smaller after accounting for students' socio-economic backgrounds. But in all 17 countries and economies, students who use a computer at home perform better than those who do not, even after accounting for students' socio-economic backgrounds.

Computer access and use at school

Chapter 5 shows that in almost all countries and economies, most schools have at least one computer (Table VI.5.8). However, the number of computers available for students varies greatly within and across countries. This section thus applies a ratio of the number of computers per student as an indicator of computer access at school and examines how students' performance in digital reading differs between students in schools with below the national average ratio of computers per student and students in schools with above the national average ratio.

No consistent pattern is observed across countries (Table VI.6.3). In Austria, Chile and the partner country Colombia, students in schools with an above-average ratio of computers per student tend to perform better than students in schools with a below-average ratio. In contrast, in Korea, Japan, Hungary, Poland, Iceland and the partner economy Hong Kong-China, students in schools with a below-average ratio of computers per student tend to perform better than students in schools with an above-average ratio. In nine other countries and economies with available data, there is no performance difference between the two groups of students. The causal nature of the observed relationships is difficult to establish, and may result from the influence of third factors. For example, lower scores may be associated with greater access to computers because lower-performing students may use computers more in practical classes than higher-performing students do in more academically oriented courses.

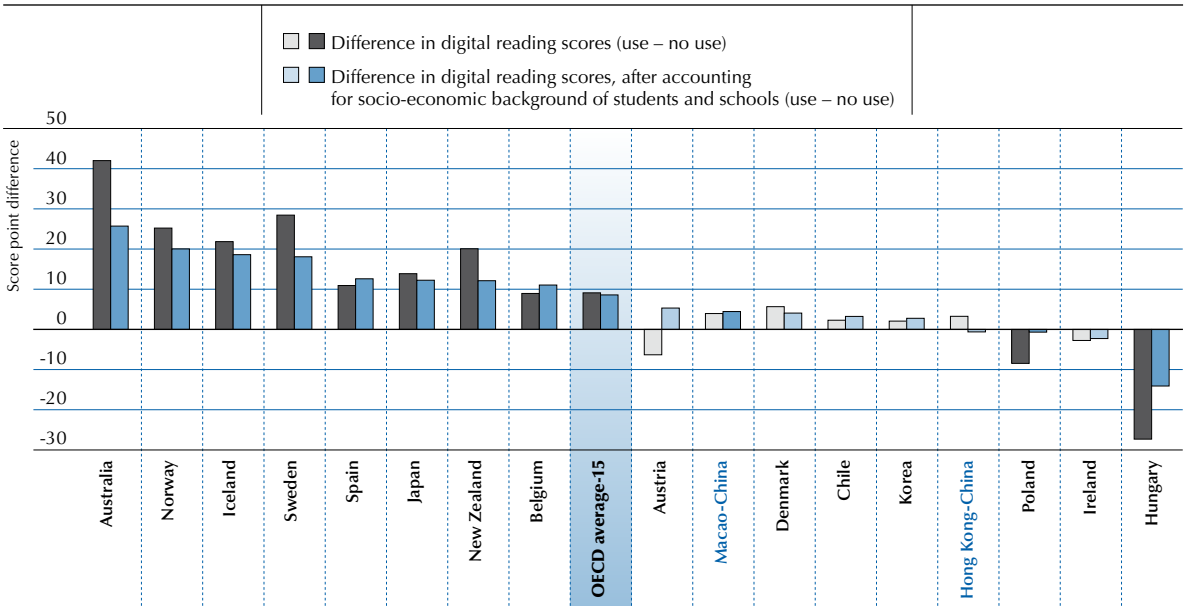
The relationship between the computer-per-student ratio of in school and the socio-economic background of schools varies across countries. In some countries, schools with an above-average ratio of computers per student are socio-economically advantaged, while in other countries, such schools are disadvantaged (Table VI.6.3). After accounting for the socio-economic background of students and schools, in almost all countries and economies there is no performance difference between students in schools with below- and above-average ratios of computers per student. In Belgium and the partner economy Macao-China, however, students in schools with an above-average ratio of computers per student tend to perform better than students in schools with a below-average ratio, after accounting for students' and schools' socio-economic backgrounds. In the partner economy Hong Kong-China, students in schools with a below-average ratio of computers per student tend to perform better than students in schools with an above-average ratio, even after accounting for students' and schools' socio-economic backgrounds.

There is also no consistent pattern across countries in the performance difference between students who reported using computers at school and students who reported that they do not use computers or had no access to computers at school, as shown in Figure VI.6.2. In eight countries – Australia, Sweden, Norway, Iceland, New Zealand, Japan, Spain and Belgium – students who use computers at school tend to perform better than students who do not use computers at school, whereas in two countries – Hungary and Poland – students who do not use computers at school tend to perform better than students who do. But in seven countries and economies there is no performance difference between these two groups of students.

In many countries, the socio-economic backgrounds of schools are not related to whether students use or do not use computers at school (Table VI.6.4). So, even after accounting for the socio-economic backgrounds of students and/or schools, the performance differences between the two groups remain in all OECD countries, except Poland, where the performance advantage for students who do not use computers at school disappears after accounting for students' and schools' backgrounds, since socio-economically disadvantaged students are more likely to use computers at school than advantaged students.

■ Figure VI.6.2 ■

Difference in digital reading scores between students who use a computer at school and those who do not



Note: Values that are statistically significant are marked in a darker tone.
Countries are ranked in descending order of the performance difference after accounting for socio-economic background of students and schools.
Source: OECD, *PISA 2009 Database,* Table VI.6.4.
StatLink http://dx.doi.org/10.1787/888932435454

DIFFERENT TYPES OF COMPUTER USE AND PERFORMANCE

Use of computers at home and performance

Students' use of computers at home for leisure and their performance in digital reading

Students use computers at home for various activities. How is the frequency of students' use of computers for leisure-related activities related to their performance in digital reading? As explained in detail in Chapter 5, students were asked to report how often they use a computer at home for the following activities: play one-player games; play collaborative online games; use e-mail; chat on line; browse the Internet for fun; download music, films, games or software from the Internet; publish and maintain a personal website, weblog or blog; and participate in online forums, virtual communities or spaces. Students' responses to these eight activities – "never or hardly ever", "once or twice a month", "once or twice a week" or "every day or almost every day" – were combined to make an *index of computer use at home for leisure*. The higher the value on this index, the more frequently students use computers at home for leisure. Labels in Box VI.6.1 are used to refer to each group of students.

Box VI.6.1 **Labels for each group of students: Students' use of computers**

Bottom quarter on the index	Second quarter on the index	Third quarter on the index	Top quarter on the index
Rare users	Moderate users		Intensive users

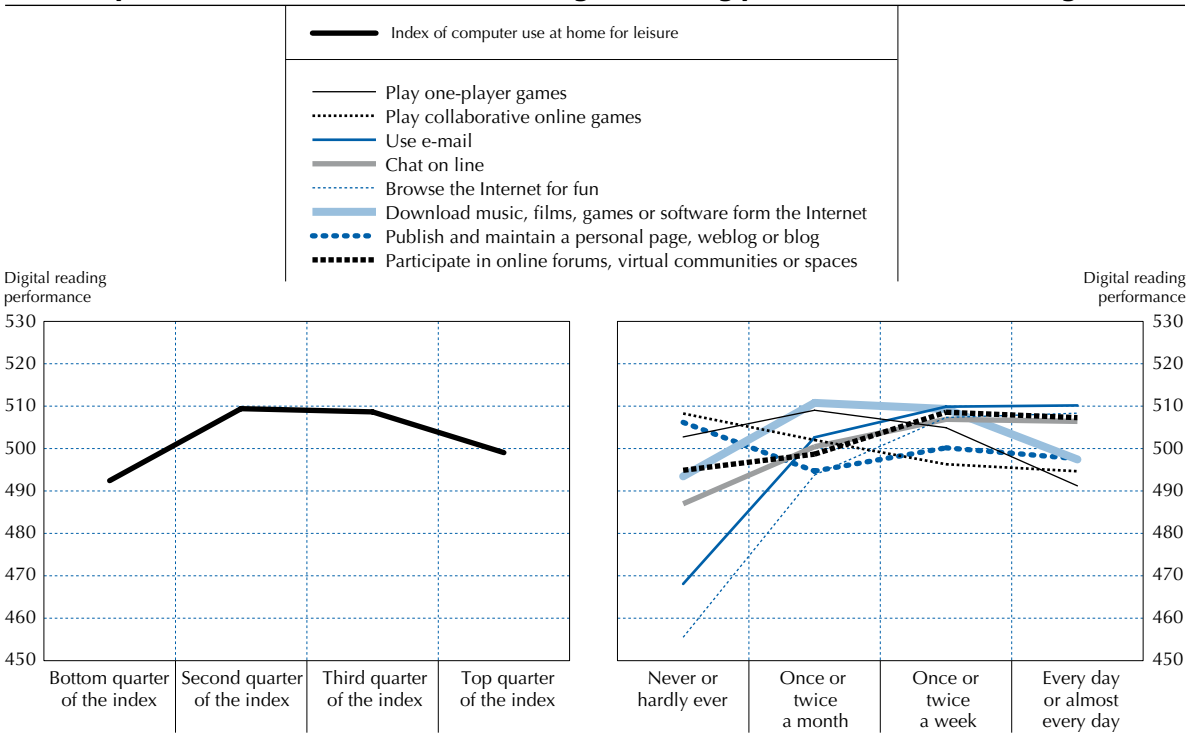
Never or hardly ever	Once or twice a month	Once or twice a week	Every day or almost every day
Infrequent users	Sporadic users		Daily users

Across OECD countries, students who use computers at home for leisure at a moderate level of frequency perform better than rare users: students in the bottom quarter of this index average 492 score points, while students in both the second and third quarters of this index average 509 score points. Intensive users – students in the top quarter of this index – average 499 score points, which is lower than the scores attained by moderate users (Table VI.5.14). In general, as shown in the left panel of Figure VI.6.3, the relationship between performance and the frequency of computer use at home for leisure is not linear, but rather mountain-shaped: it rises from rare users to moderate users then falls from moderate users to intensive users. This finding is also supported by the quadratic regression analysis[1] (Table VI.6.5a).

Across OECD countries, each of the eight activities, except the activity "play collaborative online games", shows a similar pattern in the relationship with performance as that of the index in general. As shown in the right panel of Figure VI.6.3, students who never or hardly ever use a computer at home to play collaborative online games tend to achieve the highest scores (508 score points), followed by students who use a computer at home for this purpose once or twice a month (502 score points) (Table VI.6.5c). Students who use a computer at home for this purpose at least once a week perform at the lowest levels compared with other students (496 score points for once or twice a week and 495 score points for every day or almost every day).

■ Figure VI.6.3 ■

Computer use at home for leisure, and digital reading performance, OECD average-15



Source: OECD, *PISA 2009 Database*, Tables VI.5.14 and VI.6.5b-i.
StatLink http://dx.doi.org/10.1787/888932435454

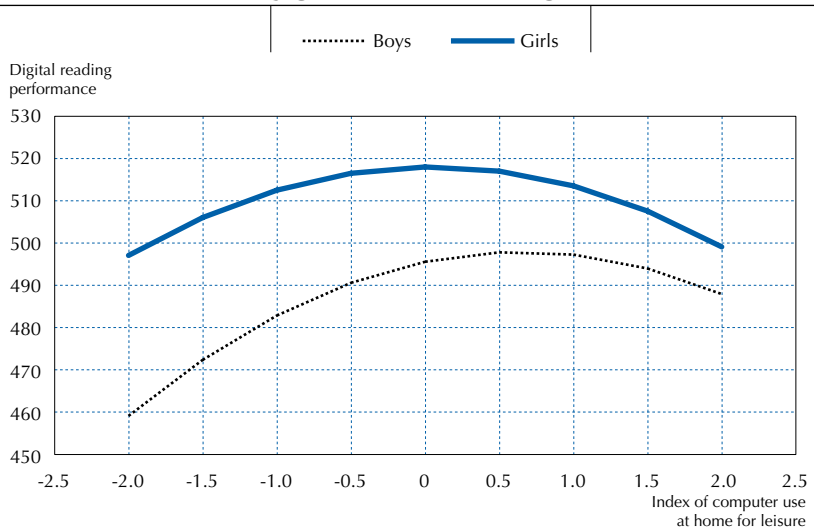
The pattern of the relationship between the *index of computer use at home for leisure* and performance varies across countries. Japan, Poland, Hungary, Spain, Denmark and the partner economies Hong Kong-China and Macao-China show a pattern similar to the OECD average, which is that moderate users perform better than rare users, and intensive users perform around the same level as or at lower levels than moderate users, while still performing better than rare users.[2] In Chile, there is a positive linear relationship between the *index of computer use at home for leisure* and performance, which means that the more frequently students use a computer at home for leisure, the better they perform. In contrast, in Norway, Korea and Austria, both the index and the square of the index are negatively related to performance, which means that intensive users achieve lower scores than moderate and rare users.

The frequency of computer use at home for leisure is highly related to students' socio-economic background: as discussed in Chapter 5, in most participating countries and economies, socio-economically advantaged students tend to use computers at home more frequently for leisure (Table VI.5.14). After accounting for students' socio-economic backgrounds, therefore, only in Japan, Chile and the partner economy Hong Kong-China, do those students who use computers at home more for leisure perform better than those who do not (Table VI.6.5a).

The pattern of the relationship between the frequency of students' use of computers at home for leisure and performance seems to be different for girls and boys. Figure VI.6.4 presents this relationship separately for boys and girls across OECD countries. Among boys, intensive users tend to perform better than rare users, while among girls intensive users tend to perform at around the same level as rare users.

■ Figure VI.6.4 ■

Index of computer use at home for leisure, and digital reading performance, by gender, OECD average-15

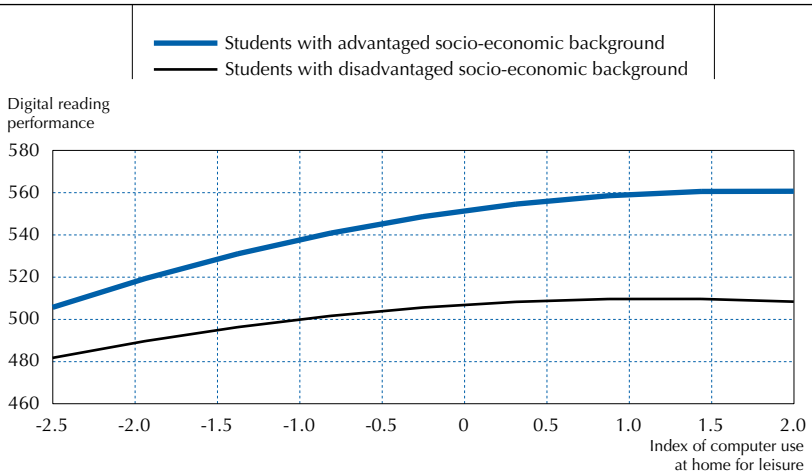


Source: OECD, *PISA 2009 Database,* Table VI.6.5a.
StatLink http://dx.doi.org/10.1787/888932435454

While the pattern of the relationship between the index and performance does not differ greatly between socio-economically advantaged and disadvantaged students across OECD countries, in some countries it varies according to students' socio-economic background (Table VI.6.5a). Among socio-economically disadvantaged students in Hungary and Norway, the relationship shows a gentle mountain-shaped pattern – rare users and intensive users perform at similar levels and moderate users perform better than both of them – while among advantaged students the relationship is negative, shown by a curve: moderate users perform at the same level or slightly better than rare users, while intensive users attain lower scores than rare and moderate users. In Japan, the relationship is positive, and illustrated by a curve, for both disadvantaged and advantaged students, but the line is steeper among advantaged students; that is, moderate users perform better than rare users, and intensive users perform better than moderate users (Figure VI.6.5a). In Chile, Iceland, Poland and Spain, the patterns are different between advantaged and disadvantaged students, and this difference is apparent in the shape of the curve. In Poland and Spain, a mountain-shaped pattern is gentler for disadvantaged students than for advantaged students, meaning that the performance advantage for moderate users compared with rare or intensive users is greater among advantaged students than among disadvantaged students. In contrast, in Iceland, a mountain-shaped pattern is steeper for disadvantaged students than for advantaged students. Among advantaged students in Chile, moderate users perform better than rare and intensive users, and intensive users perform better than rare users; while among disadvantaged students, the more frequently students use computers at home for leisure, the better they perform (Figure VI.6.5b).

■ Figure VI.6.5a ■

Index of computer use at home for leisure, and digital reading performance, by socio-economic background (Japan)



Note: Disadvantaged socio-economic background is defined as one standard deviation below the OECD average on the *PISA index of economic, social and cultural status,* while advantaged socio-economic background is one standard deviation above the OECD average.

Source: OECD, *PISA 2009 Database,* Table VI.6.5a.

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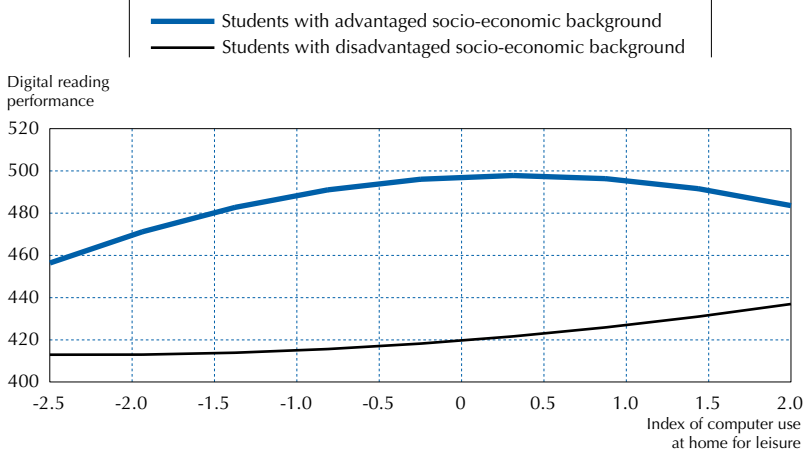
■ Figure VI.6.5b ■

Index of computer use at home for leisure, and digital reading performance, by socio-economic background (Chile)



Note: Disadvantaged socio-economic background is defined as one standard deviation below the OECD average on the *PISA index of economic, social and cultural status,* while advantaged socio-economic background is one standard deviation above the OECD average.

Source: OECD, *PISA 2009 Database,* Table VI.6.5a.

StatLink http://dx.doi.org/10.1787/888932435454

Use of computer at home for schoolwork

Students use computers at home not only for leisure but also for their schoolwork. How is the frequency of students' use of a computer at home for schoolwork related to their performance in digital reading? Is the relationship different from that between frequency of use for leisure and performance? Students were asked to report how frequently – "never or hardly ever", "once or twice a month", "once or twice a week" or "every day or almost every day" – they use computers at home for the following five activities: browse the Internet for schoolwork; use e-mail to communicate with other students about schoolwork; use e-mail to communicate with teachers and submit homework or other schoolwork; download, upload or browse material from the school's website; and check the

school's website for announcements. If students reported that they use computers for these activities "every day or almost every day" or "once or twice a week", they were considered frequent users of computers. Students' responses to these six questions were combined to make an *index of computer use at home for schoolwork*. The higher the value on this index, the more frequently students use computers at home for schoolwork-related activities. Labels in Box VI.6.1 are used to refer to each group of students.

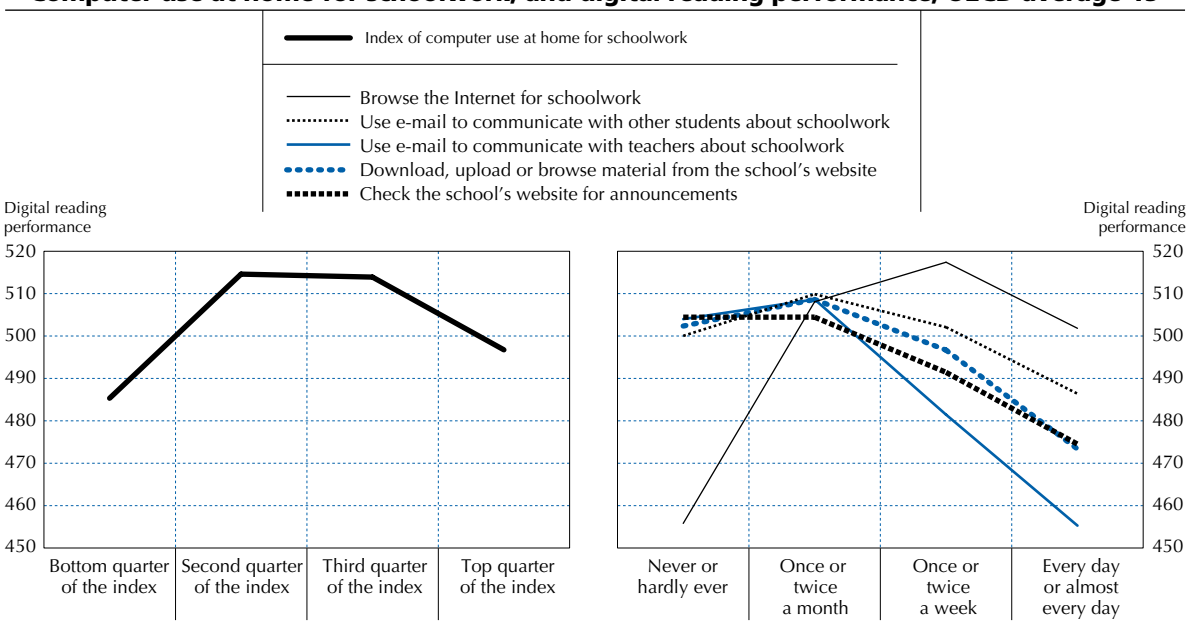
Across OECD countries, students who use computers at home for schoolwork at a moderate level of frequency perform better than rare users: students in the bottom quarter of this index average 485 score points, while students in the second and third quarters of this index average 515 and 514 score points, respectively. Intensive users – students in the top quarter of this index – average 497 score points (Table VI.5.16). As with students' use of computers at home for leisure, the relationship between students' use of computers at home for schoolwork and performance is not linear, but rather steeply mountain-shaped, as shown in the left panel of Figure VI.6.6. The performance advantage for moderate users and the performance disadvantage for rare users compared with intensive users are more prominent when students use a computer at home for schoolwork as compared to when they do so for leisure.

Each of the five activities shows a somewhat different pattern in the relationship between the frequency of engaging in that activity and performance. The right panel of Figure VI.6.6 shows that general use of the Internet for schoolwork seems to have a different relationship with performance than the other four, more specific, activities, which involve using a computer for communicating with others and accessing a school's website for schoolwork. When measured against the *index of computer use at home for schoolwork*, sporadic users – in this case, students who reported using a computer "once or twice a month" or "once or twice a week" for all five activities – perform better than students who reported using a computer for these purposes "every day or almost every day." For all but the activity "browse the Internet for schoolwork", infrequent users perform as well as or better than sporadic users and achieve higher scores than daily users. For the activity "browse the Internet for schoolwork", a mountain-shaped pattern emerges: both infrequent and daily users attain lower scores than sporadic users.

Since the causal relationship between these ICT activities and performance cannot be established, it cannot be concluded that more frequent use of computers at home for schoolwork results in a decline in performance. One explanation is that students who need more help or students who need more time to complete a task, tend to use computers at home for schoolwork more frequently, and these students also tend to attain lower scores than other students.

■ Figure VI.6.6 ■

Computer use at home for schoolwork, and digital reading performance, OECD average-15



Source: OECD, *PISA 2009 Database*, Tables VI.5.16 and VI.6.6b-f.
StatLink http://dx.doi.org/10.1787/888932435454

When looking at the *index of computer use at home for schoolwork* in individual countries and economies, there is no country or economy in which those students who rarely use computers at home for schoolwork perform better than moderate or intensive users (Table VI.5.16). In the majority of countries with available data, intensive users attain the same or lower scores than moderate users, and attain the same or better scores than rare users, except in the partner economy Hong Kong-China, where moderate users perform better than rare users and intensive users perform better than moderate users.

Students from socio-economically advantaged backgrounds more frequently use computers at home for schoolwork than disadvantaged students in almost all participating countries and economies except Liechtenstein, where there is no significant difference (see Chapter 5) (Table VI.5.16). After accounting for students' socio-economic backgrounds, only in Japan, Iceland and the partner economies Hong Kong-China and Macao-China is there a positive relationship between the index and digital reading performance. Still, the relationship is mountain-shaped, so that while intensive users perform better than rare users, they do not necessarily perform as well as moderate users[3] (Table VI.6.6a).

Across OECD countries, there is no difference between boys and girls in the pattern of the relationship between this index and performance. Nor is there any great difference in the pattern between socio-economically advantaged and disadvantaged students across OECD countries. But in some countries and economies, the pattern varies according to students' socio-economic background (Table VI.6.6a). In Australia, Chile, Japan, Korea, New Zealand and Sweden, moderate users perform better than rare or intensive users among both advantaged and disadvantaged students, but the performance disadvantage for intensive users compared with that of moderate users is smaller among advantaged students than among disadvantage students. In contrast, in the partner economies Hong Kong-China and Macao-China, the performance disadvantage for intensive users compared with moderate users is greater among advantaged students than among disadvantaged students.

Use of computers at school and performance

Use of computers at school

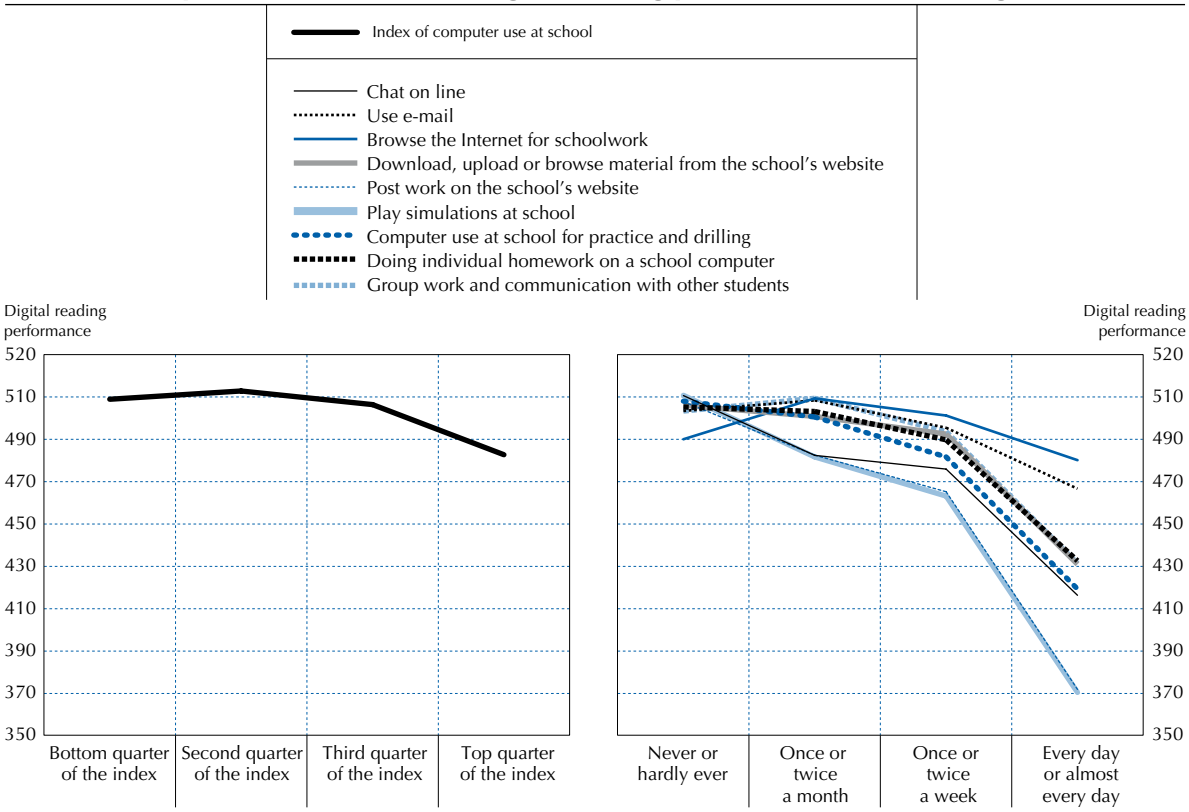
How is the frequency of students' use of computers at school related to performance? Students were asked to report how often – "never or hardly ever", "once or twice a month", "once or twice a week" or "every day or almost every day" – they use a computer at school for the nine following activities: chat on line at school; use e-mail at school; browse the Internet for schoolwork; download, upload or browse material from the school's website; post their work on the school's website; play simulations at school; practice and drilling such as for learning a foreign language or mathematics; do homework on a school computer; and use school computers for group work and communicating with other students. Students' responses to these questions were combined to make an *index of computer use at school*. The higher the value on this index, the more frequently students use computers at school. Labels in Box VI.6.1 are used to refer to each group of students.

Across OECD countries, students who use computers at school at a moderate level of frequency perform slightly better than, or at the same level as, rare users: students in the bottom quarter of this index average 509 score points, while students in the second and third quarters of this index average 513 and 506 score points, respectively (Table VI.5.18). Intensive users – students in the top quarter of this index – perform at the lowest level (483 score points). The relationship between students' use of computers at school and performance tends to be negative with a slight curve, as shown in the left panel of Figure VI.6.7.

Figure VI.6.7 illustrates that each of the nine school ICT activities shows a slightly different pattern in the relationship between the frequency of computer use at school and performance. For using e-mail at school, browsing the Internet for schoolwork, doing homework on a school computer, and using school computers for group work and communicating with other students, the pattern of the relationship is similar to that between the index and performance: students who use computers at school for these activities "once or twice a month" perform best, followed by students who "never or hardly ever" use computers at school for these activities, while students who use computers at school for these activities "every day or almost every day" achieve the lowest scores. In contrast, for chatting on line at school, downloading, uploading or browsing material from the school's website, posting their work on the school's website, playing simulations at school, and engaging in drills and practice, such as for learning a foreign language or mathematics, students who use computers at school for these activities "never or hardly ever" achieve the highest scores, and the more frequently students use computers at school for these activities, the lower their scores.

■ Figure VI.6.7 ■

Computer use at school and digital reading performance, OECD average-15

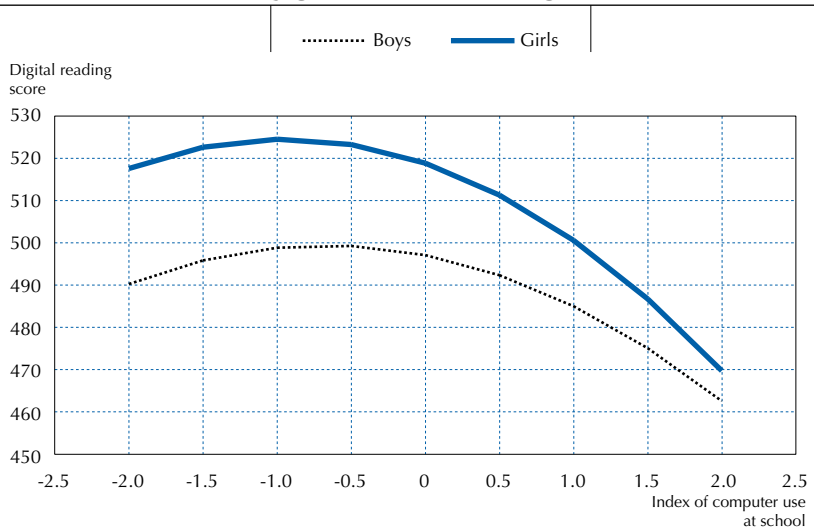


Source: OECD, *PISA 2009 Database,* Tables VI.5.18 and VI.6.7b-j.

StatLink http://dx.doi.org/10.1787/888932435454

■ Figure VI.6.8 ■

Index of computer use at school, and digital reading performance, by gender, OECD average-15



Source: OECD, *PISA 2009 Database,* Table VI.6.7a.

StatLink http://dx.doi.org/10.1787/888932435454

Examining the *index of computer use at school*, in Hungary, Poland, Denmark, Chile and the partner economy Hong Kong-China, rare users generally perform better than moderate users and moderate users perform better than intensive users. In New Zealand, Spain, Belgium, Sweden, Norway, Austria, Korea and Ireland, rare and moderate users perform at similar levels and both perform better than intensive users. In Iceland and Australia, rare and intensive users perform at similar levels and they do not perform as well as moderate users. In Japan and the partner economy Macao-China, performance in digital reading is similar for rare, moderate and intensive users (Table VI.5.18).

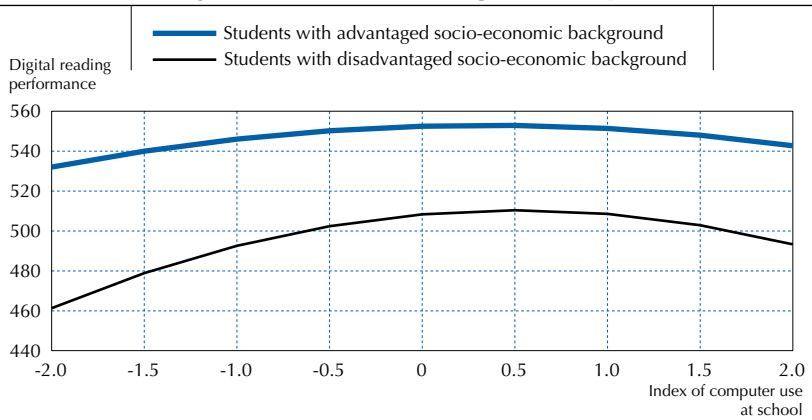
Students' socio-economic backgrounds are not highly related to students' use of computers at school (Table VI.5.18). Even after accounting for students' socio-economic backgrounds, the performance advantage for moderate users compared to that for frequent users remains consistent or decreases only slightly[4] (Table VI.6.7a).

The pattern of the relationship between performance and the frequency of students' use of computers at school seems to be different between girls and boys (Figure VI.6.8). The performance disadvantage for girls who use computers intensively as compared to girls who use computers moderately or rarely is much greater than the performance disadvantage for boys who use computers intensively compared to those who use them moderately or rarely. Perhaps there is a difference in attitudes towards and interest in using computers between the boys and girls who use computers intensively at school.

The pattern of the relationship between the index and performance does not differ greatly between socio-economically advantaged and disadvantaged students across OECD countries, although it does in a few countries and economies (Table VI.6.7a). In Belgium, among both advantaged and disadvantaged students, moderate users perform better than rare or intensive users, and rare users perform better than intensive users; but the performance disadvantage for intensive users compared with rare or moderate users is greater among advantaged students than among disadvantaged students. In Japan, among both advantaged and disadvantaged students, moderate users perform better than rare or intensive users, and intensive users perform better than rare users; but the performance advantage for moderate users compared with rare users is greater among disadvantaged students than among advantaged students (Figure VI.6.9). In Denmark, the relationship is negative among both advantaged and disadvantaged students, but among advantaged students the relationship is more linear.

■ Figure VI.6.9 ■

Index of computer use at school, and digital reading performance, by socio-economic background (Japan)



Note: Disadvantaged socio-economic background is defined as one standard deviation below the OECD average on the *PISA index of economic, social and cultural status*, while advantaged socio-economic background is one standard deviation above the OECD average.

Source: OECD, *PISA 2009 Database*, Table VI.6.7a.

StatLink http://dx.doi.org/10.1787/888932435454

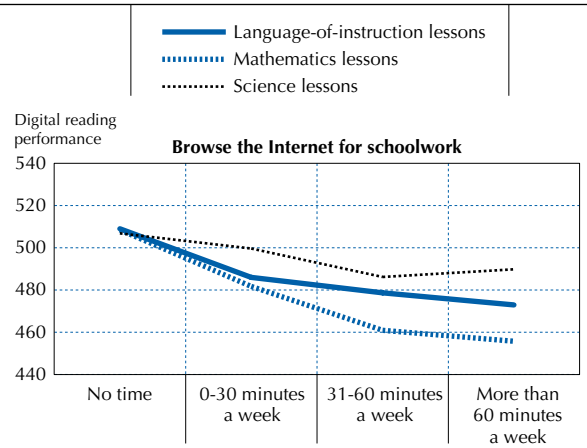
Intensity of computer use in core school lessons

As discussed in Chapter 5, in PISA 2009 students reported for the first time how much time – "no time"; "0-30 minutes"; "30-60 minutes" or "60 minutes or more" – they spend during a typical school week using a computer in language-of-instruction, mathematics and science class. Students' responses to these questions also provide information on the extent to which ICT is used during regular core subject lessons.

Figure VI.6.10a shows that, across OECD countries, students who spend no time using a computer during school lessons perform the best, and the more time students spend using a computer during school lessons, the lower their scores in all three core subjects. This finding should be interpreted with care: it does not necessarily suggest that spending more time using a computer in lessons results in poorer performance. Possible explanations are that lower-performing students who require additional help are provided with disproportionate time on a computer for remedial purposes, and/or those countries that show strong negative relationship between performance and the intensity of computer use in school lessons have not effectively integrated ICT in a pedagogically meaningful way. In fact, the relationship between performance and the intensity of computer use in school lessons varies greatly across countries. Figure VI.6.10b shows that in the countries where ICT is highly integrated into school lessons, the performance disadvantage for students who use computers intensively in school lessons is smaller than in the countries where ICT use in school lessons is not prevalent.

■ Figure VI.6.10a ■

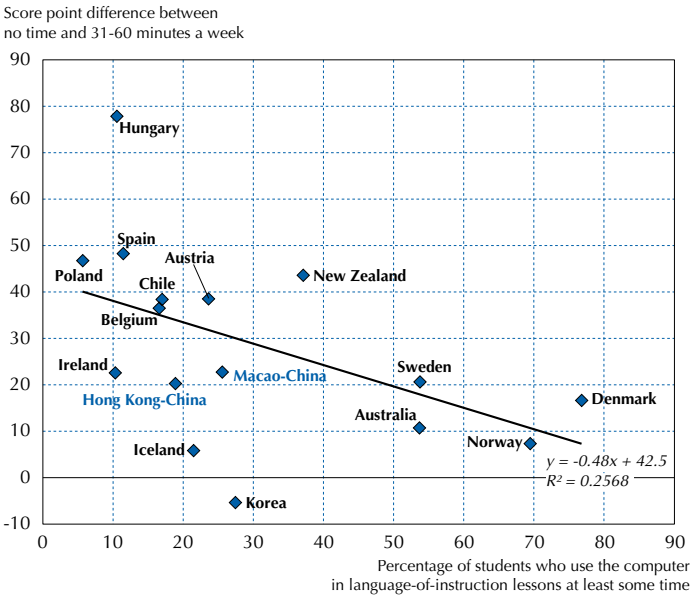
Intensity of computer use in school lessons, and digital reading performance, OECD average-15



Source: OECD, *PISA 2009 Database,* Tables VI.6.8c-f.
StatLink http://dx.doi.org/10.1787/888932435454

■ Figure VI.6.10b ■

Prevalence of computer use in school lessons, and difference in digital reading performance according to intensity of computer use in school lessons



Source: OECD, *PISA 2009 Database,* Tables VI.5.20 and VI.6.8c.
StatLink http://dx.doi.org/10.1787/888932435454

RELATIONSHIP BETWEEN SELECTED COMPUTER ACTIVITIES AND PERFORMANCE IN DIGITAL READING, IN DETAIL

The previous section shows that the relationship between digital reading and students' use of computers varies greatly, depending on what the computer is used for. This section examines in greater depth a few of the selected ICT activities – namely using home computers to play collaborative online games, browse the Internet for fun, browse the Internet for schoolwork, use e-mail to communicate with other students about homework, and use school computers to browse the Internet for schoolwork and to practice and drill. These activities have been chosen as they show distinctive patterns in the relationship between performance in digital reading and each type of ICT activity. For example, using a computer at school to browse the Internet for schoolwork and to drill and practice were chosen as representing ICT use at school. The pattern of the relationship with digital reading performance differs greatly between these activities: there is a linear negative relationship between digital reading performance and engaging in drills and practice, while this does not hold for browsing the Internet for schoolwork.

However, while the different patterns of the relationship could be partly due to the different kinds of activities, they could also be associated with other student characteristics. In order to take this into account, the relationship between digital reading performance and each activity is examined after accounting for students' cognitive skills, represented here as print reading scores. This is then followed by an analysis of the relationship between these activities and navigation skills.

Computer use at home

Comparing students who reported engaging in collaborative online games with varying levels of frequency, those who never or hardly ever do so score the highest in digital reading across OECD countries. Compared with these students, students who play collaborative online games once or twice a month score 6 points lower, students who play once or twice a week score 12 points lower, and students who play every day or almost every day score 14 points lower (Figure VI.6.11). One possible explanation for this is that these students spend most of their time playing games and do not spend enough time studying. In order to account for this, the relationship between frequency of playing games and performance in digital reading is compared among students who show similar levels of academic performance. After accounting for students' performance in print reading as a proxy for academic performance, students who play collaborative online games once or twice a month score 5 points higher, those who play once or twice a week score 8 points higher, and those who play every day or almost every day score 12 points higher than students who never or hardly ever play these games.

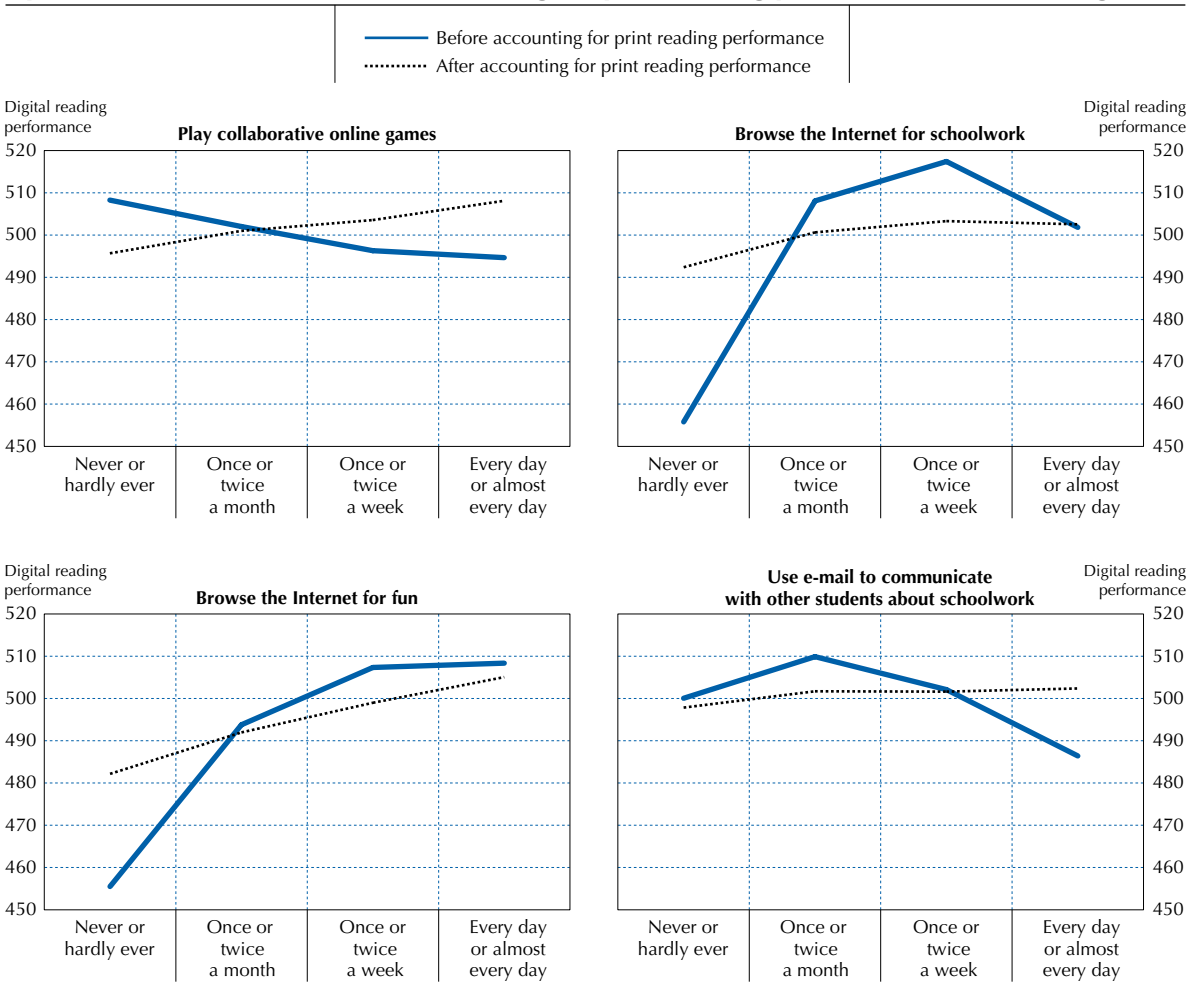
Unlike playing collaborative online games, browsing the Internet at home for fun has a positive relationship with digital reading performance, even before accounting for students' reading proficiency. But, after accounting for print reading performance, the relationship becomes more linear. For example, before accounting for print reading performance, students in OECD countries who never or hardly ever browse the Internet for fun at home score the lowest. Compared with these students, students who browse the Internet for fun once or twice a month score 38 points higher, and students who do this once or twice a week score 52 points higher. Students who browse the Internet for fun every day or almost every day score at about the same level as students who do so once or twice a week (Figure VI.6.11). After accounting for students' performance in print reading, students who never or hardly ever browse the Internet for fun at home score the lowest; and compared with these students, students who browse the Internet for fun once or twice a month score 10 points higher, students who do so once or twice a week score 17 points higher, and students who do so every day or almost every day score 23 points higher.

Comparing students who reported browsing the Internet at home for schoolwork with varying levels of frequency, those who never or hardly ever do so perform the worst. Compared with these students, those who browse the Internet for schoolwork once or twice a month score 52 points higher, and students who do so once or twice a week score 62 points higher. But students who browse the Internet for schoolwork every day or almost every day attain lower scores than students who do so once or twice a month (Figure VI.6.11). Students who browse the Internet for schoolwork at home every day might be those who need additional information from the Internet in order to complete their schoolwork. After accounting for students' performance in print reading, the relationship between digital reading performance and the frequency of browsing the Internet at home for schoolwork is close to linear: students who never or hardly ever browse the Internet at home for schoolwork score the lowest. Compared with them, students who browse the Internet at home for schoolwork once or twice a month score 8 points higher, student who do so once or twice a week score 11 points higher, and students who do so every day or almost every day perform at almost the same level as students who do so once or twice a week.

Before accounting for students' reading proficiency, daily use of computers at home to communicate by e-mail with other students about schoolwork is associated with poorer performance in digital reading. Across OECD countries, students who use the computer for this purpose every day or almost every day score 14 points lower than students who never or hardly ever do so, before accounting for print reading performance, while students who do so once or twice a month score the highest. Students who never or hardly ever use computers at home to e-mail other students about schoolwork and students who do so once or twice a week perform at similar levels in digital reading (Figure VI.6.11). Students who frequently use e-mail to communicate with other students about schoolwork are probably those who need help from their classmates in order to complete schoolwork. After accounting for students' performance in print reading, infrequent users perform less well than all others, while sporadic and daily users show similar performance.

■ Figure VI.6.11 ■

Frequency of computer use at home for leisure and schoolwork, and digital reading performance, before and after accounting for print reading performance, OECD average-15



Source: OECD, *PISA 2009 Database*, Tables VI.6.9a, b, c, d.
StatLink http://dx.doi.org/10.1787/888932435454

Computer use at school

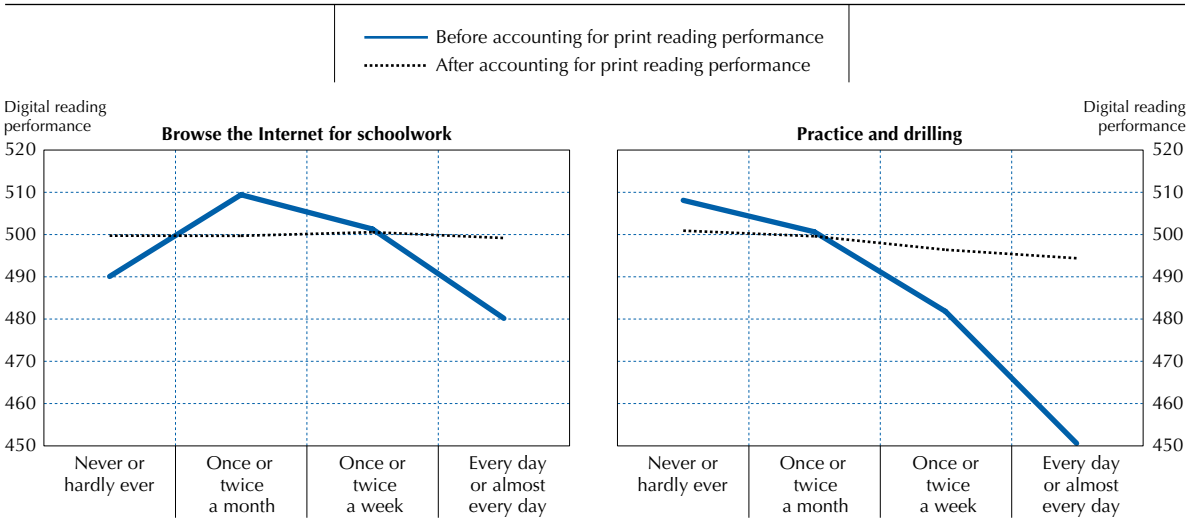
Students who sporadically use computers at school for browsing the Internet for schoolwork perform the best across OECD countries: students who do so once or twice a month score 19 points higher and student who do so once or twice a week score 11 points higher than students who never or hardly ever do so. But students who do so every day or almost every day score 10 points lower than students who never or hardly ever do so (Figure VI.6.12).

These daily users could be students who need to spend more time to complete schoolwork, or those to whom teachers give additional tasks to help them catch up with their classmates. When students with similar levels of print reading proficiency are compared, they achieve the same level of digital reading proficiency, regardless of how frequently they use computers at school for browsing the Internet for schoolwork.

Across OECD countries, there is a clear negative relationship between the frequency of computer use for engaging in drills and practice and digital reading performance: students who never or hardly ever use computers at school for this purpose score the highest. Compared with these students, students who use home computers for this purpose once or twice a month score 7 points lower, students who do so once or twice a week score 26 points lower, and students who do so every day or almost every day score 58 points lower (Figure VI.6.12). However, as most students who use computers at school for practice and drills would do so for remedial purposes, when the relationship is compared among students who have similar levels of print reading proficiency, this negative relationship is not as prominent. After accounting for proficiency in print reading, students in OECD countries who use computers at school once or twice a month for this purpose perform at the same level as students who never or hardly ever do; while students who do so once or twice a week score 5 points lower, and students who do so every day or almost every day score 7 points lower than students who never or hardly ever do.

■ Figure VI.6.12 ■

Frequency of computer use at school, and digital reading performance, before and after accounting for print reading performance, OECD average-15



Source: OECD, *PISA 2009 Database,* Tables VI.6.10a and b.
StatLink http://dx.doi.org/10.1787/888932435454

Navigation and computer use at home and at school

When comparing students who have similar levels of print reading proficiency, the more frequently students use a computer at home for leisure – playing collaborative online games and browsing the Internet for fun – the better the digital reading performance. However, this linear and positive relationship is less obvious when using home computers for schoolwork – browsing the Internet for schoolwork and using e-mail to communicate with other students about schoolwork – and it is not observed in using computers at school – browsing the Internet for schoolwork and for practice and drills.

Students seem to develop navigation skills by using computers at home for leisure. As discussed in Chapter 3, navigation skills are an essential and unique part of digital reading. Figure VI.6.13a presents the average number of relevant pages visited,[5] depending on the frequency of ICT use, and according to student performance in print reading. In this analysis, students are grouped as among those who attained above the national average score in print reading and those who performed below the national average.[6] The relationship between the average number of relevant pages visited and the frequency of ICT use could differ according to the level of students' cognitive skills, which is represented here as print reading performance.

Box VI.6.2 Relationship between ICT activities and performance in print reading, mathematics and science

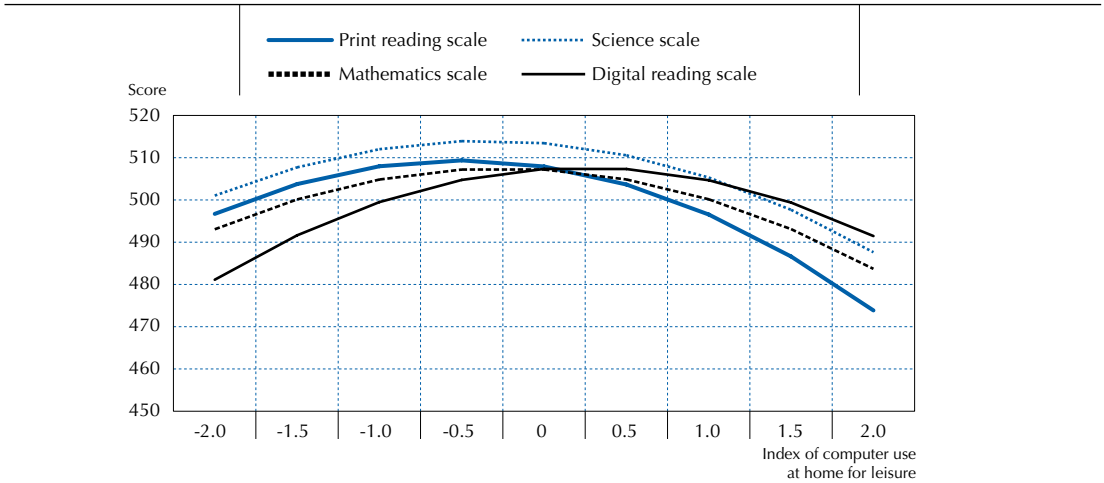
What is the relationship between students' ICT activities and their performance in print reading, mathematics and science? Is it similar to that between ICT activities and performance in digital reading? The *index of computer use at home for leisure*, the *index of computer use at home for schoolwork* and the *index of computer use at school* are used to measure how these indices are related to student performance in print reading, mathematics and science. The results discussed below are based on the average among the 15 OECD countries that participated in the ICT familiarity questionnaire and the digital reading assessment.

The relationship between using a computer at home for leisure and performance differs across assessment areas.

The relationship between the *index of computer use at home for leisure* and performance in digital reading is mountain-shaped: it rises from rare users to moderate users then falls from moderate users to intensive users. A similar mountain-shaped relationship is observed in all three PISA assessment areas – print reading, mathematics and science. However, the shape of the curves differs slightly, depending on the subject. The performance disadvantage for rare users compared with moderate users is smaller in the three main subjects than it is in digital reading, while the performance disadvantage for intensive users compared with moderate users is greater in the three main subjects – especially in print reading – than it is in digital reading.

■ Figure VI.6.A ■

Index of computer use at home for leisure, and performance in print reading, digital reading, mathematics and science, OECD average-15



Source: OECD, *PISA 2009 Database,* Tables VI.6.5a, A6.1, A6.2 and A6.3.
StatLink http://dx.doi.org/10.1787/888932435454

Among both boys and girls, the relationship between computer use for leisure and performance differs between digital reading and the three main subjects. Figure VI.6.4 shows that the patterns of the relationship between the *index of computer use at home for leisure* and performance in digital reading are different for boys and girls. Among boys, the relationship is positively linear with a slight curve, meaning that intensive users achieve slightly lower scores than moderate users, but they perform much better than rare users. Among girls, the pattern is mountain-shaped, meaning that moderate users perform better than rare and intensive users, and rare and intensive users tend to perform at around the same levels. These patterns are different from those found in the three main assessment areas. In print reading, mathematics and science, among boys, moderate users perform better than rare and intensive users, and rare and intensive users perform at around the same levels; among girls, the relationship is negatively linear with a slight curve, meaning that rare users achieve slightly lower scores than moderate users, but they perform much better than intensive users.

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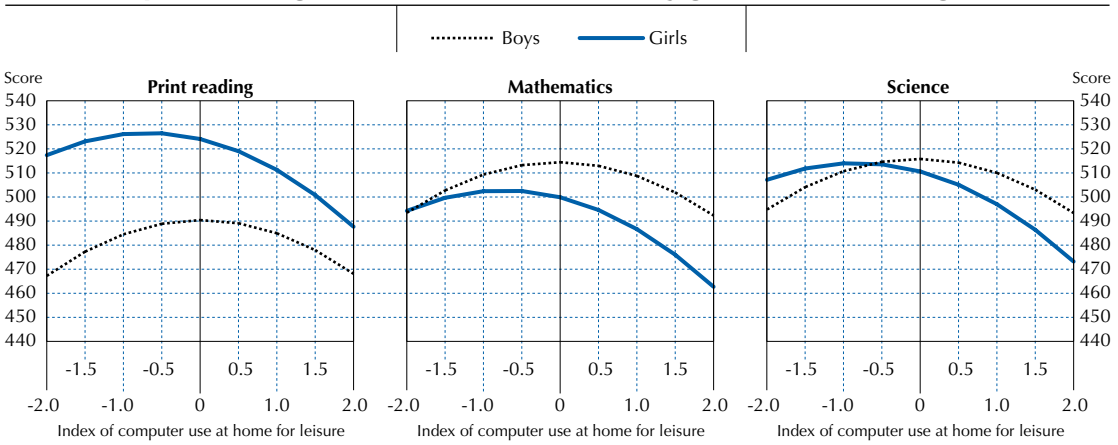
■ Figure VI.6.B ■

Index of computer use at home for leisure, and performance in print reading, mathematics and science, by gender, OECD average-15



Source: OECD, *PISA 2009 Database,* Table A6.1, A6.2 and A6.3.
StatLink http://dx.doi.org/10.1787/888932435454

In summary, the performance advantage for boys who use computers intensively is observed in digital reading, but not in the three main subjects. While there is no performance disadvantage in digital reading for girls who use computers intensively, there appears to be one in the three main assessment areas. Thus, the relationship between the *index of computer use at home for leisure* and performance is not the same in digital reading and in the three main PISA subjects.

The relationship between using a computer at home for schoolwork and performance does not vary across assessment areas, nor does the relationships between using a computer at school and performance

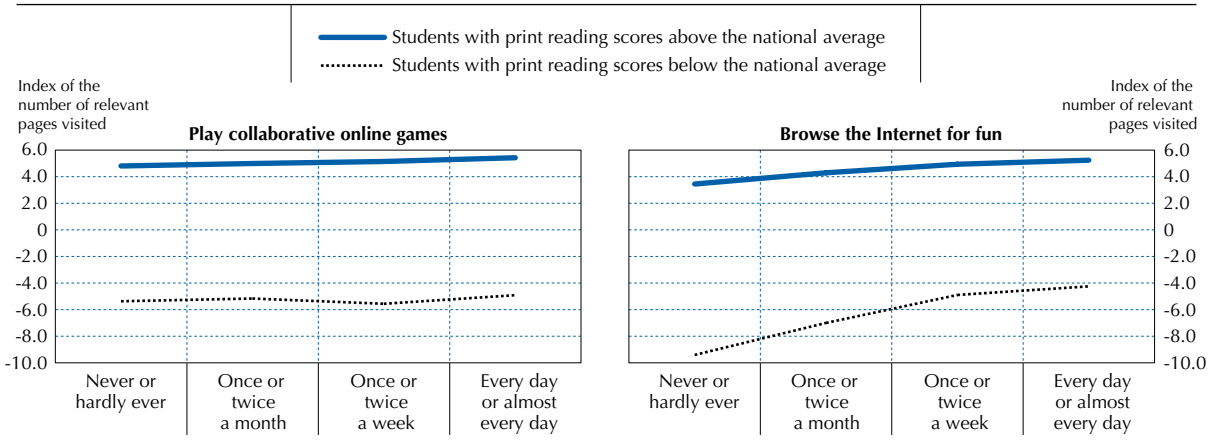
For the *index of computer use at home for schoolwork* and the *index of computer use at school*, the patterns of the relationship with performance do not vary across the assessment areas. The relationship between the *index of computer use at home for schoolwork* and performance is mountain-shaped: it rises from rare users to moderate users then falls from moderate users to intensive users, but intensive users perform better than rare users. The relationship between the *index of computer use at school* and performance is negative with a curve: it rises slightly from rare users to moderate users then falls from moderate users to intensive users, meaning that intensive users attain much lower scores than rare users.

The patterns of the relationship between the *index of computer use at home for schoolwork* and performance in digital reading are different between boys and girls, as shown in Figure VI.6.8. The performance disadvantage for girls who intensively use a computer at home for schoolwork compared to those who only rarely or moderately use a home computer for that purpose is much greater than the performance disadvantage for boys who are intensive users compared to those boys who are rare or moderate users. These patterns are also observed in the three main assessment areas. The patterns of the relationship between the *index of computer use at school* and performance for boys and girls are similar between digital reading and all three main assessment areas.

Among the students with above-average performance, across OECD countries, the *index of the number of relevant pages visited* is 4.8 for students who never or hardly ever use computers at home to play collaborative online games. Since this index is based on an individual country's average, this can be interpreted to mean that these students visited an additional 4.8 relevant pages compared with the average number of relevant pages visited by students in that country. In contrast, the *index of the number of relevant pages visited* is 5.4 for students who use a computer at home every day or almost every day to play collaborative online games (Figure VI.6.13a). This means that daily users visited an average of about one-half page more of relevant text than infrequent users did.

■ Figure VI.6.13a ■

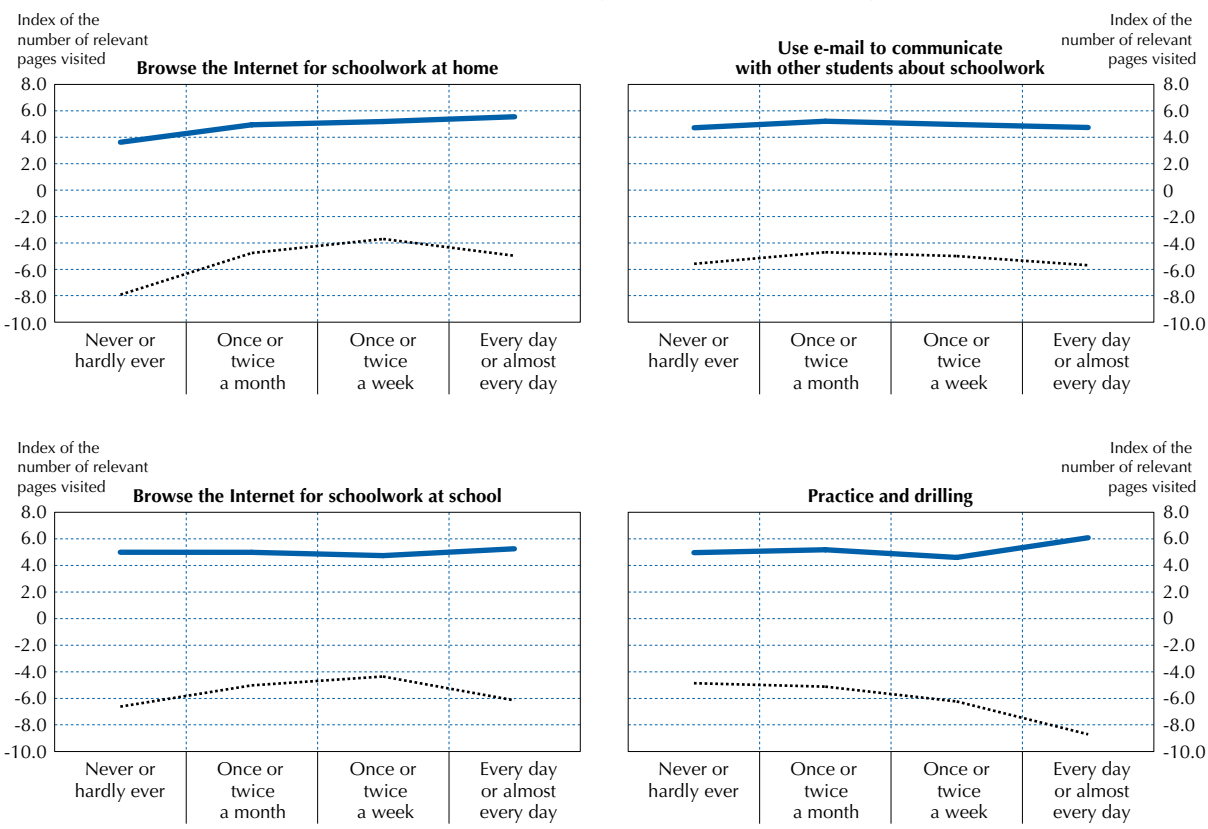
Index of the number of relevant pages visited, by frequency of computer use at home for leisure, OECD average-15



Source: OECD, *PISA 2009 Database,* Tables VI.6.11a and b.
StatLink http://dx.doi.org/10.1787/888932435454

■ Figure VI.6.13b ■

Index of the number of relevant pages visited, by frequency of computer use at home for schoolwork and computer use at school, OECD average-15



Source: OECD, *PISA 2009 Database,* Tables VI.6.11c-f.
StatLink http://dx.doi.org/10.1787/888932435454

This difference is more prominent when considering browsing the Internet at home for fun. Among students in OECD countries with above-average performance in print reading, those who use a computer at home every day or almost every day to browse the Internet for fun visit two additional relevant pages compared with students who never or hardly ever use a computer at home for that purpose (Table VI.6.13b). Among students with below-average performance in print reading, similar relationships are observed, even though the pattern is somewhat unclear for "play collaborative online games" while the pattern is very clear for "browse the Internet for fun".

In contrast, using computers for schoolwork does not seem be related to developing navigation skills. For example, across OECD countries, there is no positive relationship between the *index of the number of relevant pages visited* and the frequency of computer use at home to browse the Internet for schoolwork and to use e-mail for communicating with other students about schoolwork, nor with the frequency of computer use at school to browse the Internet for schoolwork and to play simulations (Figure VI.6.13b). Students who use computers frequently for schoolwork might just be following instructions and might not have much chance to search for information by themselves.

STUDENTS' SELF-CONFIDENCE IN DOING ICT TASKS

Students' self-confidence in using computers and performance

Besides performing well in digital reading, it is also important that students perceive themselves as capable of completing high-level ICT tasks in this technology-rich society. But students' self-reported confidence in doing these types of tasks is related to their performance in digital reading. When students have greater self-confidence in doing ICT tasks, do they perform better in digital reading? Students were asked to indicate the extent to which they are able to do each of the following five tasks on a computer: "edit digital photographs or other graphic images"; "create a database"; "use a spreadsheet to plot a graph"; "create a presentation"; and "create a multi-media presentation". Students responded to each statement by selecting from the options "I can do this very well by myself", "I can do this with help from someone", "I know what this means but I cannot do it" and "I don't know what this means". Students' responses to these five questions were combined to make an *index of self-confidence in ICT high-level tasks*.The higher the value on this index, the greater the self-confidence students reported.

Box VI.6.3 **Labels for each group of students: Students' self-confidence in using computers**

Bottom quarter on the index	Second quarter on the index	Third quarter on the index	Top quarter on the index
Students lacking confidence	Less-confident students		Most-confident students

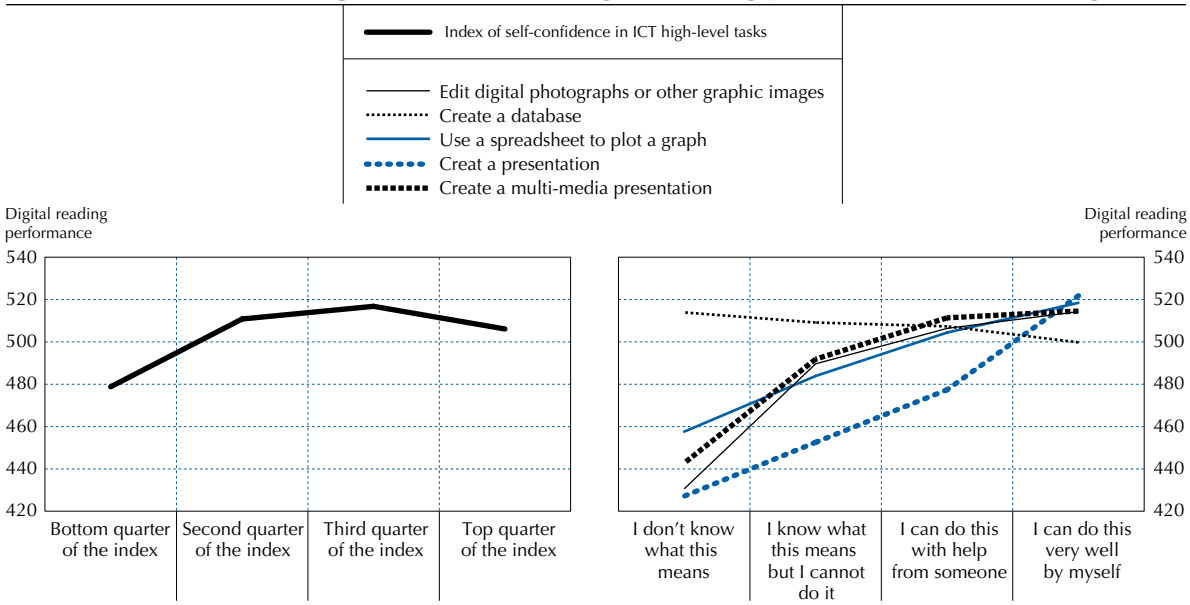
I don't know what this means	I know what this means but I cannot do it	I can do this with help from someone	I can do this very well by myself
Students with no confidence	Students with low confidence		Highly confident students

Across OECD countries, less-confident students perform slightly better than the most confident students: students in the top quarter of this index average 506 score points, while students in the second and third quarters of this index average 511 and 517 score points, respectively. Students with no confidence – those in the bottom quarter of this index – perform at the lowest level, with 479 score points. As shown in the left pane of Figure VI.6.14, students with no confidence attain much lower scores than less-confident students and the most confident students. The performance disadvantage for those with no confidence is at least 27 score points (Table VI.5.25).

The patterns of the relationship between performance and students' self-confidence in different types of ICT tasks are similar to the relationship between the *index of self-confidence in ICT high-level tasks* and performance – even though highly confident students perform better than students with low confidence in some questions (Figure VI.6.14). For the question concerning "create a database", the performance difference is small, and students with low confidence outperform highly confident students by 14 score points. This could be because only a small number of students reported that they have confidence in creating a database (Table VI5.24). Students who have confidence in creating a database might be those who have a natural affinity with and understanding of computers.

■ Figure VI.6.14 ■

Self-confidence in ICT high-level tasks, and digital reading performance, OECD average-15

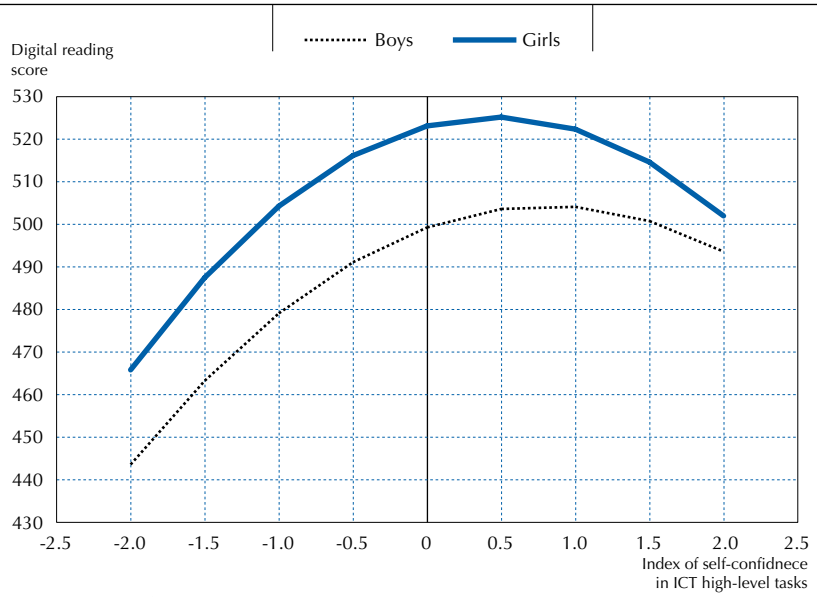


Source: OECD, *PISA 2009 Database,* Tables VI.5.25 and VI.6.12b-f.
StatLink http://dx.doi.org/10.1787/888932435454

Most countries and economies show a relationship between the *index of self-confidence in ICT high-level tasks*[7] and performance that is similar to the OECD average. In Iceland, Norway and Sweden, however, less-confident students perform at the highest level and the most-confident students perform on a par with students with no self-confidence. In Japan, Korea and the partner economy Macao-China, the more self-confident the student, the better he or she performs (Table VI.5.25). Even after accounting for students' socio-economic background, the pattern of this relationship remains similar in most countries (Table VI.6.12a).

■ Figure VI.6.15 ■

Index of self-confidence in ICT high-level tasks, and digital reading performance, by gender, OECD average-15



Source: OECD, *PISA 2009 Database,* Table VI.6.12a.
StatLink http://dx.doi.org/10.1787/888932435454

The pattern of the relationship between students' self-confidence in using computers and performance seems to be different between boys and girls (Figure VI.6.15). The most confident boys tend to perform at around the same level as less-confident boys, while the most confident girls tend to attain lower scores than less-confident girls do. The pattern of the relationship between the index and performance does not differ greatly between socio-economically advantaged and disadvantaged students (Table VI.6.12a).

Students' self-confidence in doing ICT tasks and activities

When students are engaged in ICT activities more frequently, do they have greater self-confidence in doing ICT tasks? This section examines the relationship between the frequency of various types of ICT activities and the *index of self-confidence in ICT high-level tasks*.

The top panel in Figure VI.6.16 shows that, across OECD countries, the more frequently students use computers at home for leisure, the greater their self-confidence. Students who never or hardly ever use computers at home for e-mail, chatting on line, browsing the Internet for fun, or downloading music, films, games or software from the Internet have particularly low levels of self-confidence in doing ICT tasks.

Students across the OECD area who more frequently use a home computer for schoolwork also tend to have greater self-confidence in doing ICT tasks (the middle panel in Figure VI.6.16). Students who never or hardly ever use computers at home for browsing the Internet for schoolwork have the lowest self-confidence, but this is still higher than the confidence level among students who never or hardly ever use computers at home for e-mail, chatting on line, browsing the Internet for fun, or downloading music, films, games or software from the Internet.

In general across OECD countries, there are positive relationships between the frequency of computer use at school and the level of students' self-confidence (the bottom panel in Figure VI.6.16). But the differences in confidence levels between students who never use computers at school and students who use computers at school every day or almost every day tend to be smaller than the differences in confidence levels between students who never use a computer at home and students who use a computer at home every day or almost every day (the bottom panel in Figure VI.6.16 is compared with the top and middle panels).

For example, the biggest difference in self-confidence between students who never use a computer at home – including both for leisure and schoolwork – and students who use a computer at home every day or almost every day is observed for the activity "use e-mail". Across OECD countries, students who use a computer at home for e-mailing every day or almost every day have a level of self-confidence 0.56 index points higher – over a half of the standard deviation of the index – than students who never or hardly ever do so. The smallest difference is observed for the activity "check the school's website for announcements": across OECD countries, students who use a computer at home for checking the school's website for announcements every day or almost every day have a level of self-confidence 0.33 index points higher – one-third of the standard deviation of the index – than students who never or hardly ever do so. In contrast, the biggest difference in self-confidence between students who never use computers at school and students who use computers at school every day or almost every day is observed for the activity "browse the Internet for schoolwork": across OECD countries, students who use computers at school for browsing the Internet for schoolwork every day or almost every day have a level of self-confidence 0.27 index points higher – around one-fourth the standard deviation of the index – than students who never or hardly ever do so. The smallest difference is observed for the activity "chat on line at school": across OECD countries, students who use computers at school for chatting on line every day or almost every day have a level of self-confidence 0.13 index points higher than students who never or hardly ever do so.

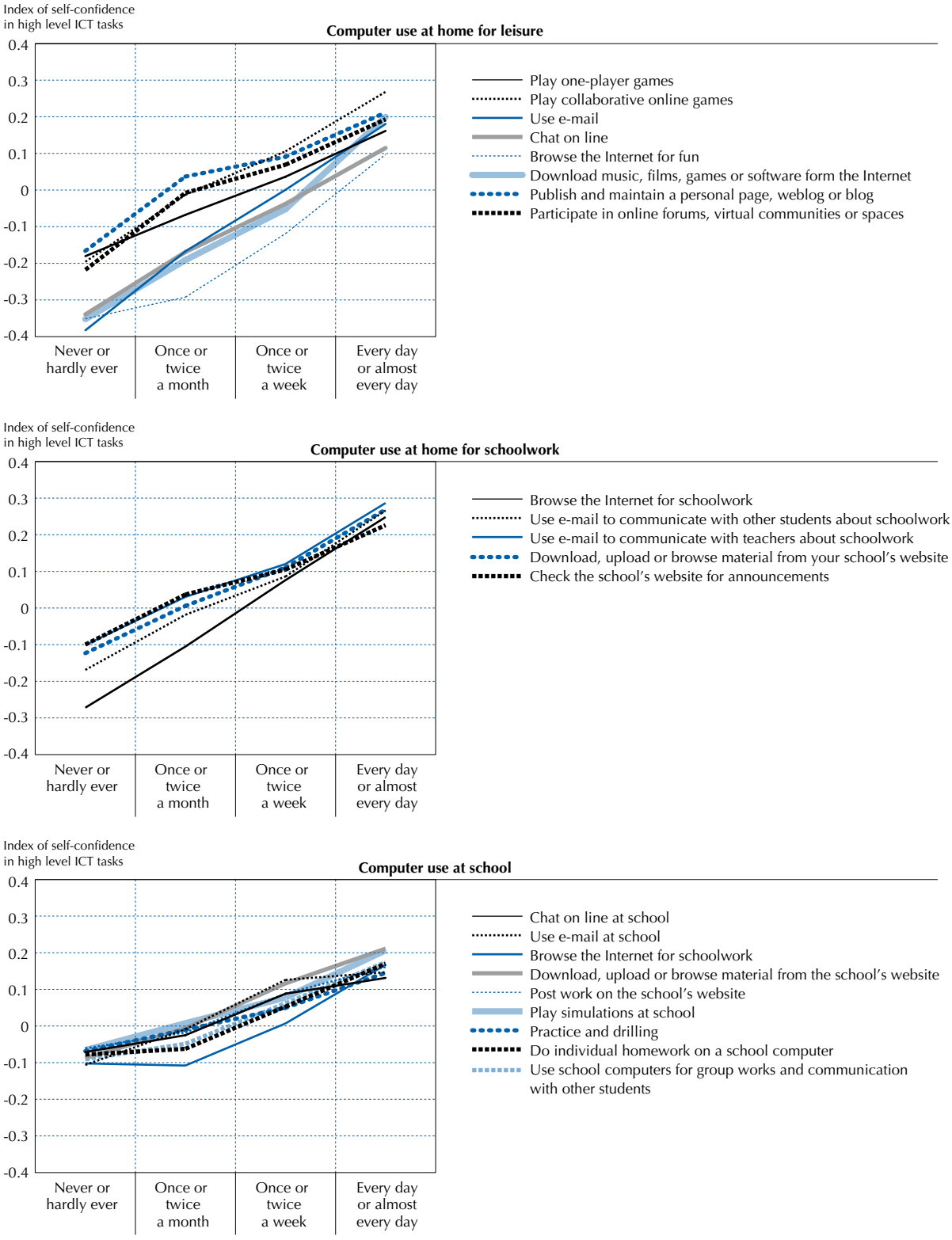
CONCLUSIONS

Using a computer at home is related to digital reading performance in all 17 participating countries and economies, even after accounting for students' socio-economic background. In contrast, the relationship between using a computer at school and digital reading performance varies across countries: it is positive in nine countries and economies, negative in one country, and makes no difference in seven countries and economies.

The pattern of the relationship between digital reading performance and the use of computers at home differs according to the reasons for use (*i.e.* for leisure or for schoolwork), but the difference in the pattern is more distinct in relation to where the computer is used (*i.e.* at home or at school). In general, the relationship between the frequency of computer use at home for leisure and for schoolwork and digital reading performance is not linear, but rather mountain-shaped: performance rises from rare users to moderate users and then falls from moderate users to intensive users.

■ Figure VI.6.16 ■

Frequency of computer use at home and school, and index of self-confidence in high-level ICT tasks, OECD average-15



Source: OECD, *PISA 2009 Database,* Tables VI.6.13a-h, VI.14a-f, VI.15.a-i.
StatLink http://dx.doi.org/10.1787/888932435454

In contrast, the relationship between students' computer use at school and performance in digital reading tends to be negative with a slight curve. One possible explanation is that those students who use computers intensively at school may require additional tasks to catch up to other students or may need more time to complete their studies.

After accounting for performance in print reading, as a proxy for academic performance, the pattern of the relationship changes. There is a positive linear relationship between performance in digital reading and computer use at home, particularly computer use for leisure, while there is no significant relationship to computer use at school. This chapter also shows that the frequency of computer use at home for leisure is positively related to navigation skills, which is an essential and unique part of digital reading, while the frequency of computer use at school is not. These findings suggest that students are developing digital reading literacy mainly by using computers at home to pursue their interests.

However, computer use at school is not positively associated with digital reading performance, even after accounting for academic performance. A negative relationship can result, for example, when systems or schools make practical use of computers a more common experience for students with lower levels of academic proficiency. It can also result from variations in how digital technologies have or have not been integrated into curricula and instructional systems. The findings in this chapter suggest that access to computers at school is not the sole determinant of performance; students who use computers at school must also develop the knowledge and skills needed to locate and use the range of information available through the computer.

Findings also reveal that the relationship between performance in digital reading and students' self-confidence in using computers tends to be positive but curvilinear: less-confident students perform slightly better than the most confident students. The confidence that students reported is somewhat linked to the frequency of computer use at home and school. Regardless of the types of activities engaged in and the location of the computer, the more frequently students use computers, the greater their self-confidence. Still, the association is stronger the more students use a computer at home for leisure.

Though frequent computer use at home, particularly for leisure, tends to build students' navigation skills and self-confidence, parents and educators may have to bear in mind that students who use computers intensively do not perform better than those who do so moderately. The performance disadvantage from intensive ICT use is more pronounced in the three main subjects than in digital reading. For example, the performance disadvantage in print reading for intensive users is greater than the performance disadvantage in digital reading. Therefore, it is important to encourage students to develop navigation skills and to foster self-confidence through using computers at home, while providing guidance on how to balance the amount of time students spend using computers with time for other activities.

Notes

1. For this analysis, the *index of computer use at home for leisure* was standardised to have zero as an average and one as the standard deviation within each country and economy.

2. In these countries and economies, the *index of computer use at home for leisure* is positively related to performance, while the square of this index, which shows how the relationship is curved, is negatively related to performance (Table VI.6.5a).

3. For this analysis, this index has been standardised to have zero as an average and one as the standard deviation within each country and economy.

4. For this analysis, this index has been standardised to have zero as an average and one as the standard deviation within each country and economy.

5. See Chapter 3 and Annex A1a for the definition of *number of relevant pages visited*.

6. Within each country, students are grouped into two categories: those who achieved below the national mean score in print reading; and those who matched or exceeded the national mean score in print reading.

7. For this analysis, this index has been standardised to have zero as an average and one as the standard deviation within each country and economy.