

Chapter 4



4

Use of Information Communication Technologies (ICT) across genders and impact on achievement

The vast majority of students have computers and Internet connections at home. Not having a computer at home is associated with poorer performance on the CBAS test. Overall, males score higher than females on the frequency of use of scales. Perhaps as a result of this, they also score higher on the confidence in using ICT scales, particularly in Iceland.

Females tend to use the Internet more for social networking activities such as chatting and email and their confidence is consequently higher for these activities. Males tend to browse the Internet, play games and download software a lot more than females and they perform advanced computer activities more frequently. Overall, males have much more confidence than females in most ICT activities, which is also found in ICT PISA 2003 results.



The following section examines the relationship between familiarity with and confidence in using ICT and achievement. Previous studies have indicated that use of computers in the home (and greater ICT confidence) is strongly correlated with higher academic achievement (Harrison, Comber, Fisher, Haw, Lewin, Lunzer, McFarlane, Mavers, Scrimshaw, 2003; Ravitz, Mergendoller & Rush, 2002). Further research specifies that only home use of computers for educational purposes was associated with higher performance (in mathematics), whereas out-of-school use of ICT was negatively associated with performance (Valentine, Marsh, Pattie and BMRD, 2005). The OECD PISA 2003 ICT report revealed that higher scores on the Internet use and Programme scales were actually associated with a drop in mathematics and reading performance, stating that “one cannot readily assume that computer usage is bound to be beneficial for students in all cases” (OECD, 2005b, p.65).

HOME ICT ACCESS AND ACHIEVEMENT IN CBAS

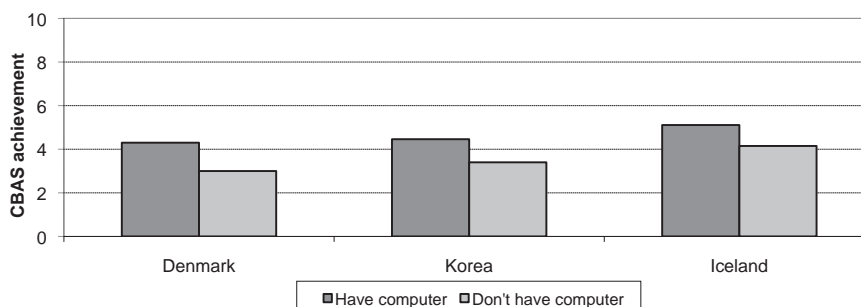
As Table 8 shows, the vast majority of students in the CBAS-participating countries had access to a computer in the home with an Internet connection. Access to educational software was less common, but the majority of students in each country still reported that they had access to educational software in the home.

Table 8.
Proportion of students in each country with a computer, educational software and Internet at home

	Have computer at home	Have educational software at home	Have Internet access at home	Number of computers in home
Denmark	98%	58%	96%	51% have three or more
Iceland	98%	69%	98%	45% have three or more
Korea	97%	62%	96%	73% have one

As to be expected, students who reported that they had a computer in the home performed better on CBAS than students who reported that they did not have a computer (although this comparison group was very small). The difference in performance in each country was approximately equal to half a standard deviation as displayed in Figure 16 below. This may be partially explained by socio-economic status as the students who do not possess a computer at home display much lower values on the PISA scale of economic, social and cultural status.

Figure 16.
Performance on CBAS and possession of computer in the home per country





ICT FAMILIARITY ITEMS AND SCALES

All countries participating in CBAS also administered the PISA ICT questionnaire during the PISA paper-and-pencil questionnaire session (along with 37 other countries which contribute to the calculation of the scale indices). This questionnaire asked students a series of 32 questions about the frequency of their computer use for specific activities and their confidence in performing specific activities on the computer. Four scales indices were computed from the collection of items measuring the four areas listed below:

ICT Internet/entertainment use

The index of ICT Internet/entertainment use was derived from students' responses about the frequency with which they use computers for the following reasons: *i*) browse the Internet for information about people, things, or ideas; *ii*) play games; *iii*) use the Internet to collaborate with a group or team; *iv*) download software from the Internet (including games); and *v*) download music from the Internet and *vi*) for communication (e.g. e-mail or "chat rooms"). A five-point scale with the response categories "almost every day", "once or twice a week", "a few times a month", "once a month or less" and "never" was used. All items were inverted and positive values on this index indicate high frequencies of ICT use.

ICT program/software use

The index of ICT program/software use was derived from students' responses about the frequency with which they use computers for the following reasons: *i*) write documents (e.g. with Word® or WordPerfect®); *ii*) use spreadsheets (e.g. Lotus 1 2 3® or Microsoft Excel®); *iii*) drawing, painting or using graphics programs; *iv*) use educational software such as mathematics programs; and *v*) writing computer programs. A five-point scale with the response categories "almost every day", "once or twice a week", "a few times a month", "once a month or less" and "never" was used. All items were inverted and positive values on this index indicate high frequencies of ICT use.

Self-confidence in ICT Internet tasks

The index of self-confidence in ICT Internet tasks was derived from students' beliefs about their ability to perform the following tasks on a computer: *i*) chat online; *ii*) search the Internet for information; *iii*) download files or programs from the Internet; *iv*) attach a file to an e-mail message; *v*) download music from the Internet; and *vi*) write and send e-mails. A four-point scale with the response categories "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" was used. All items were inverted for IRT scaling and positive scores on this index indicate high self-confidence.

Self-confidence in ICT high-level tasks

The index of self-confidence in ICT Internet tasks was derived from students' beliefs about their ability to perform the following tasks on a computer: *i*) chat online; *ii*) search the Internet for information; *iii*) download files or programs from the Internet; *iv*) attach a file to an e-mail message; *v*) download music from the Internet; and *vi*) write and send e-mails. A four-point scale with the response categories "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" was used. All items were inverted for IRT scaling and positive scores on this index indicate high self-confidence.

Table 9 below shows the model fit for a four-dimensional model for the ICT familiarity items in PISA 2006. Fit indices measure the extent to which a model, based on a particular structure hypothesised by the researcher, 'fits the data'. Model fit is assessed using Root-Mean Square Error of Approximation (RMSEA),



the Root Mean Square Residual (RMR), the Comparative Fit Index (CFI) and the Non-Normed Fit Index (NNFI). The PISA 2006 Technical Report should be consulted for further information about these techniques (OECD, 2009). Overall, the model fit was considered satisfactory for all of the CBAS participating countries and for the pooled OECD sample.

Table 9.
Model fit for CFA with ICT familiarity items

Country*	Model fit			
	RMSEA	RMR	CFI	NNFI
Denmark	0.099	0.084	0.69	0.70
Iceland	0.089	0.078	0.71	0.72
Korea	0.077	0.060	0.79	0.80
OECD	0.084	0.082	0.81	0.81

* Model estimates based on international student calibration sample (500 students per OECD country).

Table 10 shows the estimated latent correlations for the four ICT familiarity scales. All four constructs are positively correlated with each other; the highest correlations are found between the two constructs reflecting self-confidence in ICT tasks and use of the Internet and programs. Most correlations in Korea are weaker than in other countries, indicating that these scales may not be as good a measure of underlying constructs in Korea as they are in Denmark or Iceland.

Table 10.
Estimated latent correlations for ICT familiarity scales

Country	Latent correlations between					
	Internet use/ Program use	Internet use/ Internet confidence	Internet use/ High confidence Internet	Program use/ Internet confidence	Program use/ High confidence Internet	Internet confidence/ High confidence Internet
Denmark	0.58	0.42	0.42	0.17	0.42	0.53
Iceland	0.54	0.42	0.41	0.19	0.38	0.57
Korea	0.45	0.19	0.25	0.10	0.45	0.40

Table 11 shows the scale reliabilities for the ICT scales in CBAS countries and the overall median for all PISA countries that administered the ICT familiarity questionnaire. The internal consistencies were mostly high across all PISA countries but were below the median for all CBAS countries, particularly for Internet/Entertainment and Program/Software use. This should be noted when interpreting the relationship between the scales for frequency of computer use and achievement later in the report.



Table 11.
Scale reliabilities for ICT familiarity scales

Country	Internet use	Program use	Internet confidence	High confidence
Denmark	0.66	0.73	0.76	0.80
Iceland	0.69	0.75	0.74	0.77
Korea	0.66	0.71	0.81	0.82
Median	0.82	0.78	0.87	0.85

ICT FREQUENCY OF USE AND CONFIDENCE ACROSS GENDERS

Female and male scores on the ICT confidence and frequency of use scales were examined across countries and a number of differences were found between the frequency of use of computers and confidence in performing specific tasks. These patterns refer to general differences and have not been tested for statistical significance unless otherwise mentioned.

Males appear to be more frequent users of ICT programs and software than females as there are more males in the upper half of the scale and more females in the lower half. This gender difference in frequency of use is particularly strong in Iceland. Similarly, more females score in the lower half of the ICT Internet and Entertainment Use scale, particularly in Korea and Iceland. Across all three countries, males are more confident than females about performing ICT Internet activities. Further, there are more males who are confident in performing high-level ICT activities, particularly so in Iceland where the majority of males fits in the higher end of the confidence scale.

Frequency of performing specific ICT activities

The following analyses relate to differences observed in the frequency of performing specific activities examined on the ICT questionnaire and not to the ICT scales in general. Actual frequencies for each of the items on the ICT questionnaire by country and by gender are given in Annex B.

Overall, the vast majority of students, both males and females have used computers (greater than 96% across all countries). The majority of students in all three countries have been using computers for five years or more, however, in Iceland more females than males have only been using the internet for one to five years. Icelandic students also browse the Internet more often than students in Korea or Denmark with most students reporting that they browse the Internet almost daily. More males browse the Internet almost every day than females in all three countries.

Yet other activities do not display any gender differences in frequency of usage. For example, there are few gender differences in the frequency of use of the computer for writing documents across all three countries, nor for using educational software. These are relatively infrequent activities.

Male activities on the Internet differ slightly from female activities and the place of use differs slightly in that they are more likely to use computers in other places than home or school than females. Males in all three countries use the computer to play games much more often than females with a majority of males responding that they play games on a computer at least once or twice a week. In Korea and Denmark the most common response for females was that they never play games on the computer and in Iceland female responses were evenly split across once or twice a week, a few times a month, once a month or less, and never. Males in all three countries are much more likely to download music from the Internet than females. Particularly in Iceland, males tend to collaborate more on the Internet than females. Similar to the pattern



observed for playing games on the internet, males in all three countries download software more often than females and they tend to use spreadsheets more than females, although this activity is relatively uncommon across all countries. Similarly, although writing programs is another relatively infrequent activity for PISA students, it is more common for males to perform this activity than females.

Much less numerous are the activities that females tend to perform more frequently than males. They can be considered as 'social networking' activities. Females in Iceland and Denmark tend to use the computer to send and receive emails or visit chat rooms more often than males, (but the vast majority of students in both of these countries report that they use the computer almost every day for these activities). In Korea, there are few gender differences and the majority of students report that they use email or chat rooms almost every day or once or twice a week. The pattern is almost reversed for the downloading of graphics programs in Korea where more females download graphics programs almost daily and more males never do this activity.

Confidence in performing specific ICT activities

Overall, males reported higher confidence for performing computer-based activities than females. This may be as a result of their higher frequency of performing these tasks, however it may also reflect a more general trend observed in that males report higher confidence than females regardless of the activity, competency or familiarity. However there are a couple of commonly performed items that students display equal confidence for regardless of gender; most students, males and females, in all three countries felt confident about chatting via Internet and attaching files to emails.

Females report higher confidence in several items from the questionnaire across countries. For example, there is a slight gender difference in favour of females for editing photos and females appear more confident in making presentations than males. Females are also more confident about sending emails than males in Iceland and Denmark, perhaps reflecting their more frequent use of these activities, although the majority of students in all three countries are confident about sending emails without any help. In Korea there do not appear to be any gender differences.

In Iceland, in contrast to the other two countries, more females than males report high confidence about searching the Internet. Again in Iceland, there is a strong gender difference in the level of confidence about making web pages with many more females displaying higher confidence about making web pages than males. The majority of Icelandic students display higher confidence in making web pages without help, whereas in Denmark and Korea the most common response is that students can do this activity with help and there are no gender differences in degree of confidence. Finally, females are slightly more confident about using a word processor than males in Denmark and Iceland whereas there appears to be no gender difference in Korea.

On the whole, males display greater confidence for advanced activities, particularly activities on the Internet. More males than females feel confident about dealing with a virus on the computer, with the most common response for females in Denmark and Iceland being that they know how to deal with a virus, but they can't do it. Males are more confident about using databases and about copying data to CD. They are also slightly more confident about moving files, though most students say that they can do this well without help. Males are more confident than females about downloading files from the Internet, downloading music and about using spreadsheets which is not surprising given their more frequent use of these three activities. Significantly more males are confident about using multimedia in Denmark and Iceland without help whereas the most common response for females is that they can do these activities with help. In Korea there are no gender differences for this item.



Comparison of male and female confidence and frequency of use

Scores from two ICT scales relating to ICT use and from the two scales relating to confidence were added to get an overall ICT Confidence score and an overall Frequency of Use score. Scores on these scales were dichotomised into two equally sized groups: ICT frequent and infrequent users and ICT confident and unconfident. As presented in Table 12, overall, and in every country, a higher proportion of males (60%) reported that they were frequent users of ICT (combining program/software use and Internet/Entertainment use) than females (40%).¹

Table 12.

Proportion of females and males reporting frequent or less frequent use of ICT across countries

Country	Females		Males	
	ICT infrequent users	ICT frequent users	ICT infrequent users	ICT frequent users
Denmark	62.7%	37.3%	36.8%	63.2%
Iceland	62.5%	37.5%	37.4%	62.6%
Korea	54.3%	45.7%	46.6%	53.4%
TOTAL	59.8%	40.2%	40.3%	59.7%

A similar pattern for confidence in performing basic and advanced ICT tasks is revealed in Table 13 where we can observe that in Denmark and Iceland a majority of males were classified as highly confident whereas a majority of females were classified as having low confidence.² In Korea, there were no differences in patterns of confidence between females and males, however one should remember that this scale is highly skewed for Korea. What is notable in these patterns is that although over 60% of Icelandic females report that they are frequent users of the Internet and programs, only 33% report that they feel confident about performing ICT tasks.

Table 13.

Proportion of females and males reporting high or low confidence in performing ICT tasks across countries

Country	Females		Males	
	ICT low confidence	ICT high confidence	ICT low confidence	ICT high confidence
Denmark	64.1%	35.9%	35.8%	64.2%
Iceland	66.6%	33.4%	36.3%	63.7%
Korea	49.3%	50.7%	50.4%	49.6%
TOTAL	60.0%	40.0%	40.8%	59.2%



ASSOCIATION BETWEEN ICT FAMILIARITY, CONFIDENCE AND CBAS ACHIEVEMENT

Impact of frequency of ICT use on science achievement

By comparing the usage levels based on the PISA 2006 ICT indices to performance, the extent to which students using computers more across a range of ICT functions tend to do better or worse in the PISA assessment can be analysed. The answers cannot show whether certain kinds of ICT use helps students to perform better at school, but does indicate the extent to which those students who do well are also those students who use ICT for certain purposes.

This analysis looks at two broad indices of usage, one based on how often students use the Internet and play computer games, and the other based on how much they use various computer programs and educational software. Students in each country are divided into four equal groups according to their scores on each index. Those in the highest usage group are those who frequently use computers for a relatively wide range of purposes; those in the lowest are the least frequent users.

Figure 17 and Figure 18 show the average CBAS and paper-and-pencil science scores across countries and genders in relation to the frequency of Internet use. There is a slight tendency towards the U-shaped curve that was observed in the PISA 2003 ICT report for reading and mathematics (OECD, 2005b), where students using the Internet the least scored below those around the middle of the computer use distribution. In the present data, however, it is the students who use the Internet the least frequently who do not support this trend. On the whole, students in this sample who use the Internet the least score higher than students who use the Internet the most and, for the most part, than students who are moderate users of the Internet. Particularly for Danish females, one can notice a substantial drop off in achievement between females in the third quarter and females in the most frequent category of use.

Figure 17.

Students' use of the Internet and average performance in CBAS by quarter of the indices

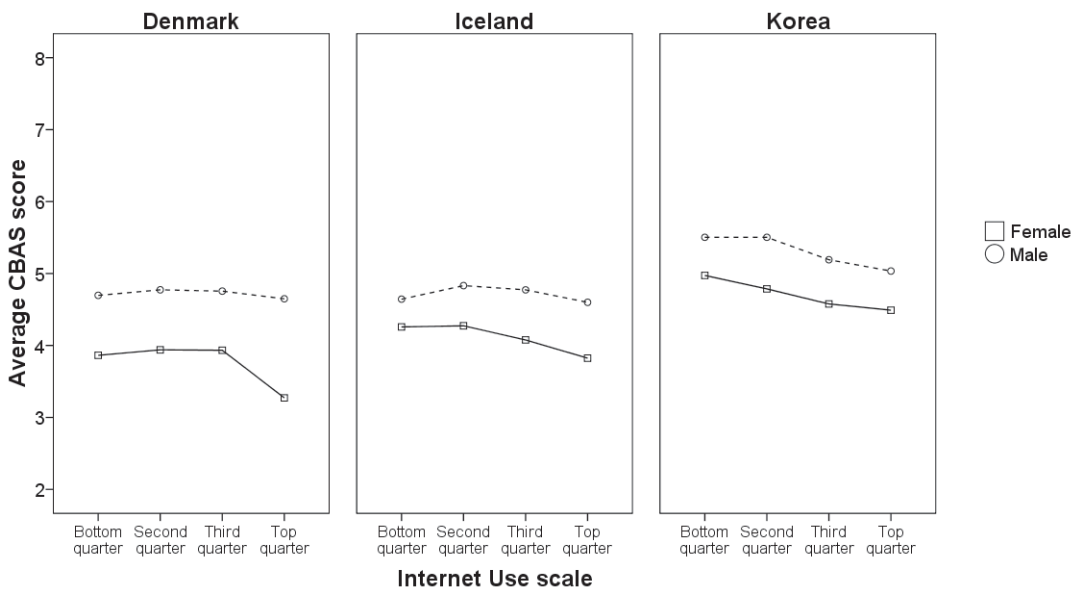
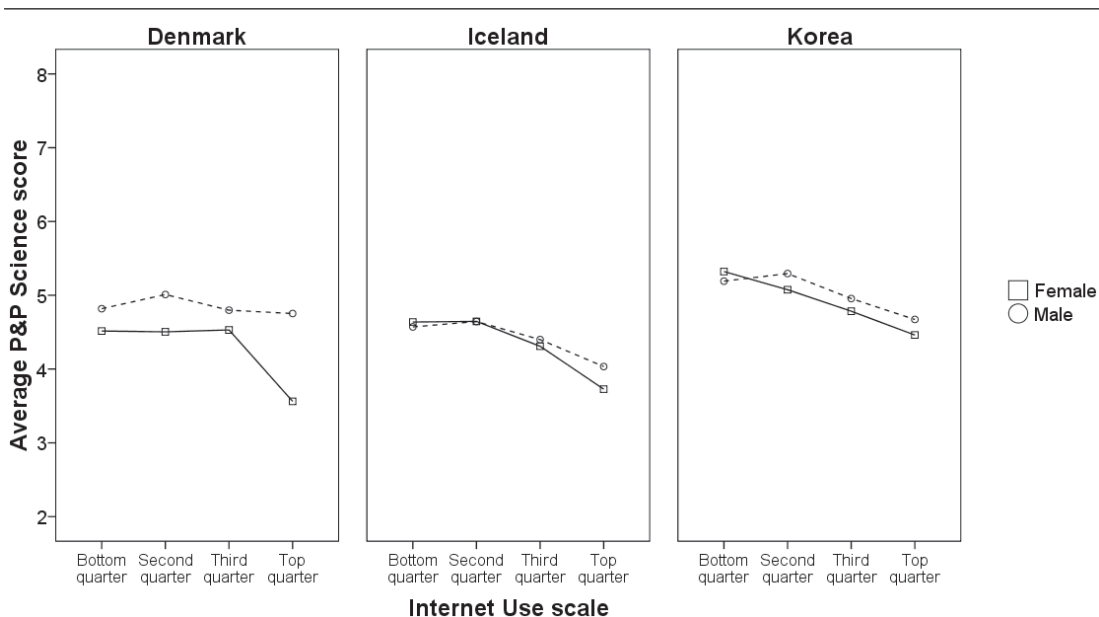




Figure 18.
Students' use of the Internet and average performance
in paper-and-pencil science by quarter of the indices



The tendency towards a U-shape is stronger in Figure 19 and Figure 20 below and are therefore better support for the pattern observed in the PISA 2003 ICT report. Overall, students who spend the least and the most time using programs are the lowest achievers and the students who show moderate frequencies of use achieve the highest performances.

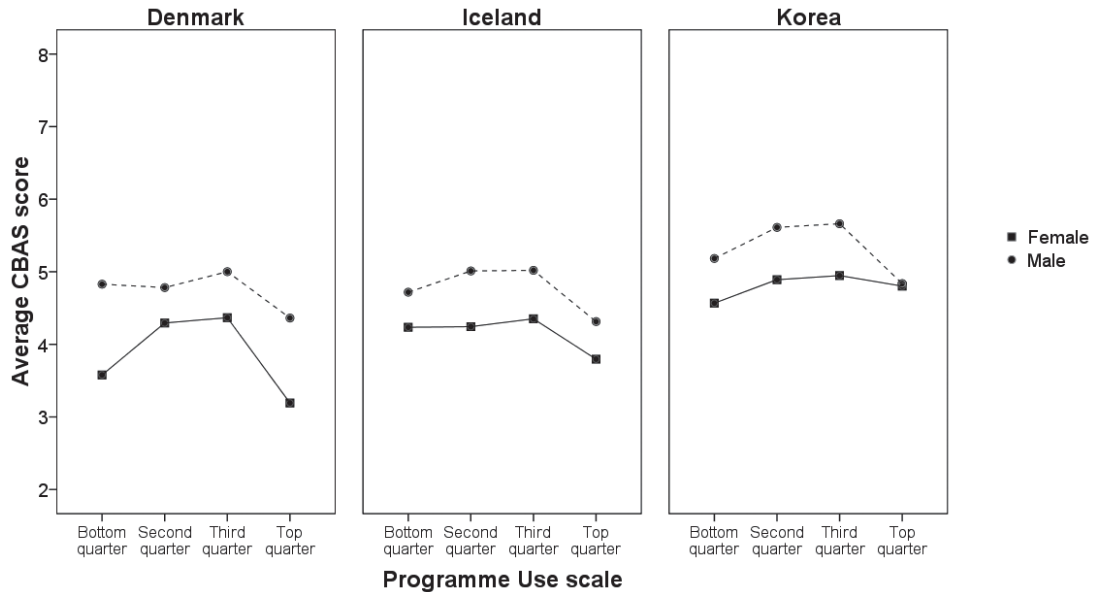
For both the paper-and-pencil and the computer-based test there are no clear gender differences across countries. In Denmark it is interesting to note that females in the middle categories almost 'catch up' to males for both paper-and-pencil science and CBAS. In Korea it is the females who use programs the most frequently that catch up on males or overtake them as males' performance drops in this category. In Iceland the gender difference with males performing better than females in CBAS but not in paper-and-pencil science seems to prevail across all categories of usage.

These results reinforce the message that one cannot readily assume that more computer usage is bound to be beneficial for students in all cases. One potential explanation of these results is that the students reporting the highest use of the Internet, playing games and using programs are doing so to the detriment of homework and other out-of-school learning activities.



Figure 19.

Students' use of programs and educational software and average performance in CBAS by quarter of the indices



Impact of ICT confidence on science achievement

By comparing the confidence levels based on the PISA 2006 ICT indices to performance, the extent to which students who are more or less confident in using computers across a range of ICT functions, tend to do better or worse in the PISA assessment can be analysed. The answers cannot show whether confidence in ICT use helps students to perform better at school, but do indicate the extent to which those students who do well are also those students who are confident performing different ICT tasks.

On the whole, the patterns of confidence displayed by females and males in Figure 21 through 24 are similar. In Denmark the trend towards a U-shaped curve appears to be the strongest out of all countries, particularly for the females. Note that in Iceland, the trend towards a U-shaped curve is stronger for achievement on the paper-and-pencil test than on the computer-based test, but on the whole the distributions appear relatively flat, indicating only a weak association between confidence and achievement.



Figure 20.
Students' use of programs and educational software and average performance in paper-and-pencil science by quarter of the indices

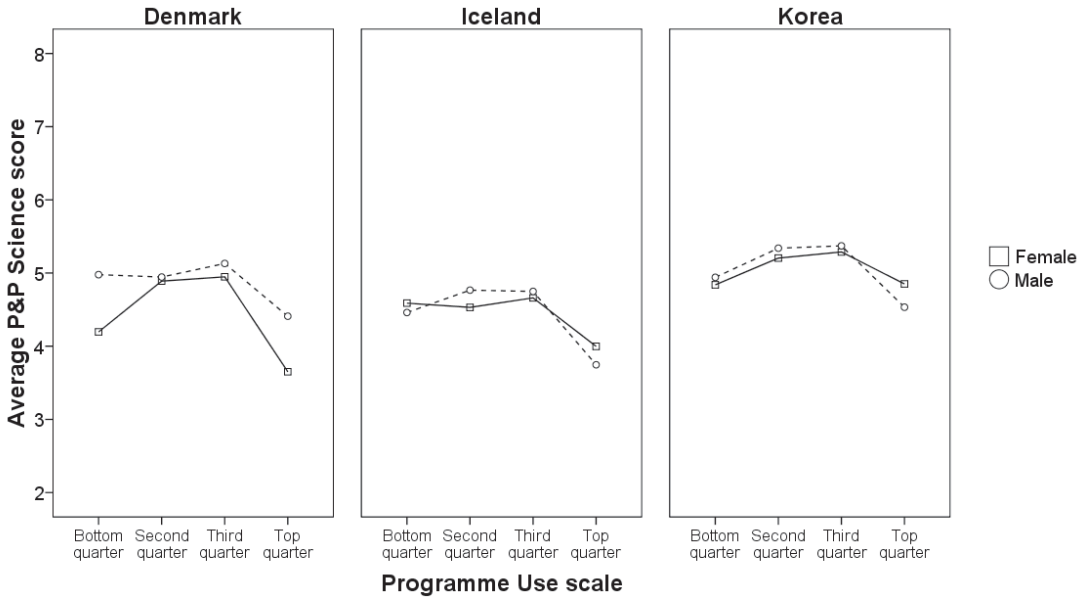


Figure 21.
Internet confidence and CBAS achievement across countries and genders³

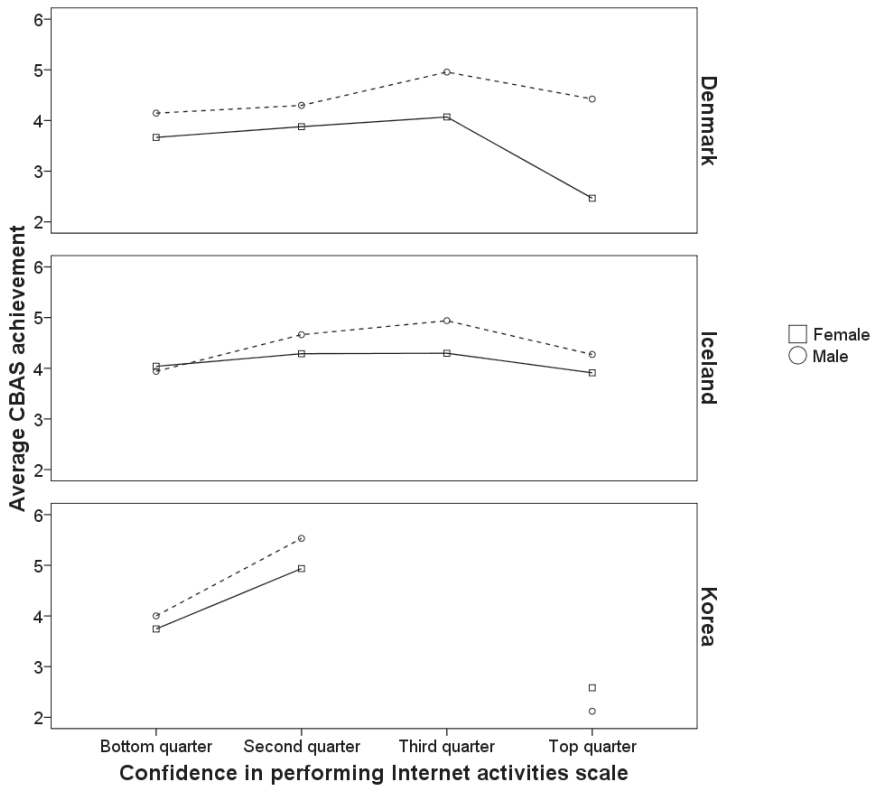




Figure 22.

Internet confidence and paper-and-pencil science achievement across countries and genders

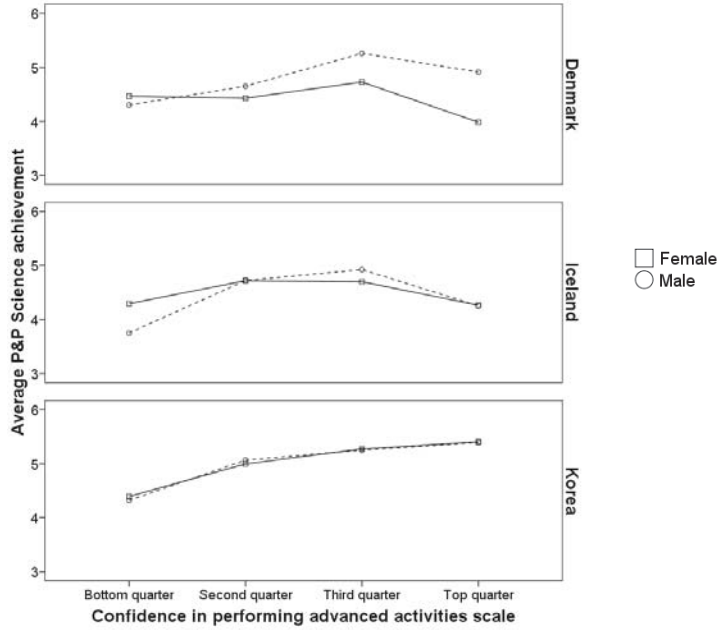


Figure 23.

Advanced ICT activities confidence and CBAS achievement across countries and genders

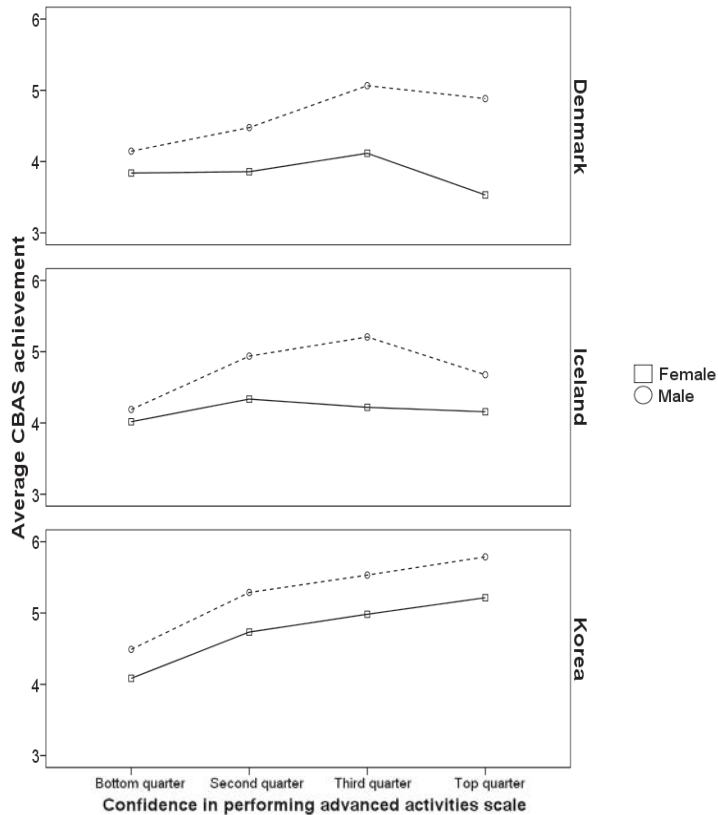




Figure 24.
Advanced ICT activities confidence and paper-and-pencil science achievement across countries and genders

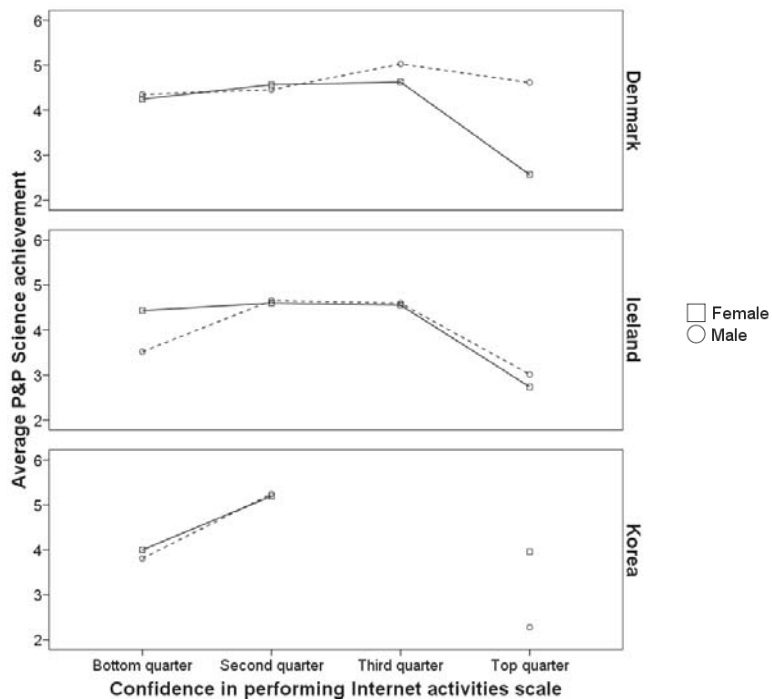
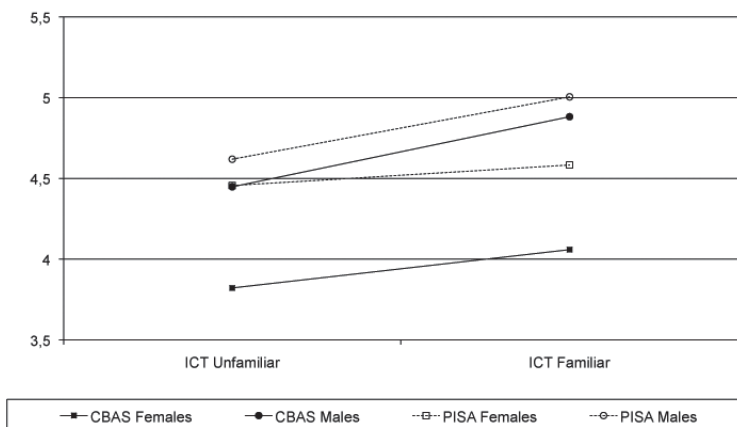


Figure 25.
Impact of ICT familiarity for male and female students on CBAS and paper-and-pencil scores in Denmark





ICT familiarity and CBAS achievement per country

The following analyses investigate the relationship between the combined measure of ICT familiarity and confidence on males' and females' performance in CBAS and paper-and-pencil science for each country.

Figure 25 shows that in Denmark, ICT familiar females and males performed better than their 'ICT-unfamiliar' counterparts on both the CBAS and paper-and-pencil test, although the size of the difference between familiar and unfamiliar students was smaller for females. Additionally, the data show that ICT familiarity is positively correlated with performance for males and females across both test modalities. This effect may be partially explained by socio-economic status which is positively correlated with ICT familiarity⁴ in the PISA paper-and-pencil test, as shown in Table 14 below, socio-economic background was positively associated with a student's performance and the strength of the relationship was approximately similar in all three CBAS countries.

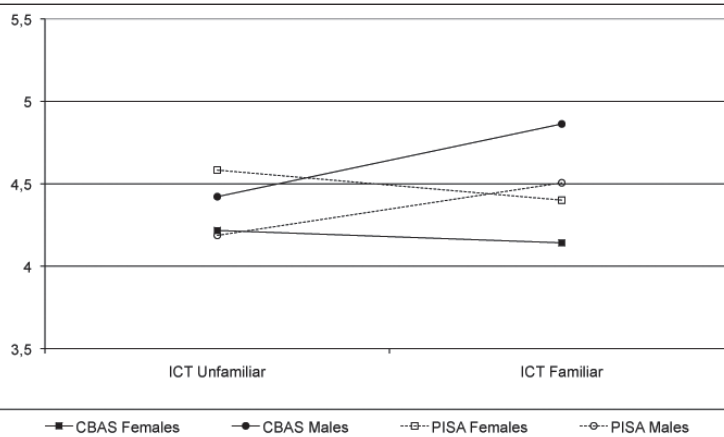
Table 14.
Score point difference on science scale associated with one unit on the ESCS (gradient)*

	Score point difference
Denmark	0.78
Iceland	0.58
Korea	0.64

*Adjusted to a similar scale used for CBAS

Figure 26 reveals that in Iceland the same pattern is present for the males, but the reverse pattern is observed for the females: high ICT familiarity is associated with poorer performance for females on both the CBAS and the paper-and-pencil tests. On the paper-and-pencil test, ICT unfamiliar females outperformed their ICT unfamiliar male counterparts. Nevertheless, the reverse was true for the ICT familiar students where males outperformed females on the paper-and-pencil test of science and on CBAS. The Icelandic females are the only group out of the three countries to display a negative correlation between ICT familiarity and achievement. This may reflect the types of activities that Icelandic females are performing on computers if these activities are not educational and time spent on the computer replaces other educational activities such as homework or out-of-school lessons. This pattern requires further investigation in the future to identify what sorts of females are ICT unfamiliar and why their performance on both the computer-based and the paper-and-pencil test is disadvantaged.

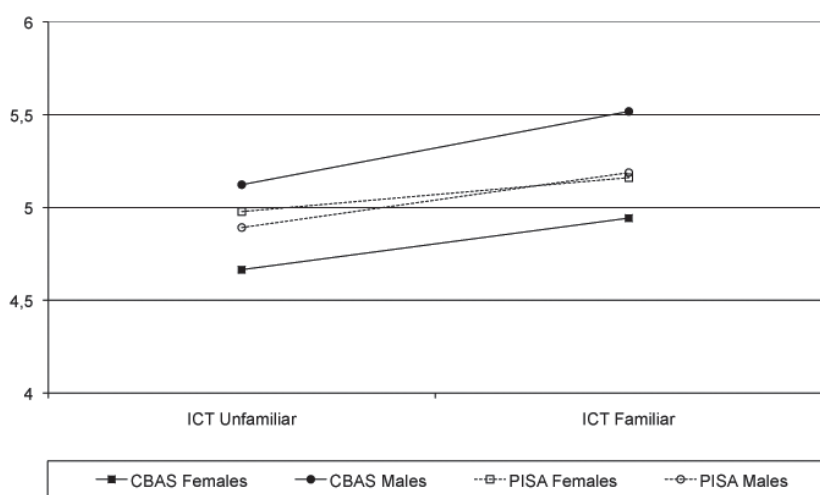
Figure 26.
Impact of ICT familiarity for male and female students
on CBAS and paper-and-pencil scores in Iceland





As shown in Figure 27, in Korea, ICT familiarity is again associated with higher scores on both CBAS and PISA for both genders, however this effect is stronger on the CBAS test than on the paper-and-pencil test and stronger for males than for females. Further, while males who are ICT familiar did not outperform females who are ICT familiar on the paper-and-pencil test, the same males do perform better than females who are ICT familiar on the CBAS test. This suggests that the CBAS test favours ICT familiar males, however it should be kept in mind when interpreting these results that the gender difference between males and females overall in Korea was not statistically significant.

Figure 27.
Impact of ICT familiarity for male and female students on CBAS and paper-and-pencil scores in Korea



These differences are summarised in the following Table 15 showing the size of the advantage for ICT familiar females and males in comparison to ICT unfamiliar students and whether these differences were significant or not. The advantage for ICT familiar males over ICT unfamiliar males is almost ¼ of a standard deviation, whereas for females the only significant advantage is for females in Korea and here the advantage is smaller. The Icelandic females stand out here once again since they are the only group for whom there is no trend towards a performance advantage for ICT familiar students (although the advantage for females in Denmark is also not significant due to the large standard error, a definite trend in this direction is present).

Table 15.
Effects of ICT familiarity on performance for male and female students across countries

	Advantage for ICT familiar female	S.E.	Advantage for ICT familiar male	S.E.
Denmark	0.21	0.21	0.46	0.19
Iceland	0.07	0.10	0.38	0.16
Korea	0.29	0.13	0.43	0.16

*Significant differences are displayed in bold



Table 16 below presents this relationship in another way, displaying the correlations for familiarity and achievement across countries which are stronger for males than for females (although on the whole they are relatively weak).

Table 16.

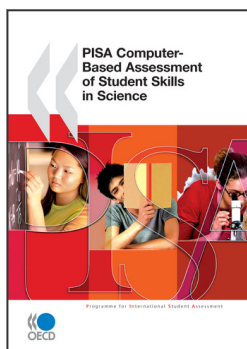
Correlations between ICT familiarity science scores on the CBAS and paper-and-pencil tests

	Paper-and-pencil		CBAS	
	Female	Male	Female	Male
Denmark	0.03	0.09	0.06	0.11
Iceland	-0.04	0.07	-0.02	0.10
Korea	0.05	0.07	0.07	0.10



Notes

1. 2x2 Chi Square results. Denmark ($\chi^2(1,1158=70) = 0.0, p<0.001$), Iceland ($\chi^2(1,3400=227) = 0.0, p<0.001$) and Korea ($\chi^2(1,2626=16) = 0.0, p<0.001$)
2. 2x2 Chi Square results: Denmark ($\chi^2(1,1154 =98) = 0.000, p<0.001$), Iceland ($\chi^2(1,3273=309) = 0.000, p<0.001$) and Korea ($\chi^2(1,2412 =0.9) = 0.182, p>0.05$)
3. ESCS – the PISA index of economic, social and cultural status that summarises various aspects of socio-economic background, including the occupational status and level of education of the students' father and mother and students' access to educational and cultural resources at home – and ICT familiarity are moderately correlated at 0.31
4. CBAS: Denmark (FET =6, $p>0.05$), Iceland (FET =16, $p<0.05$) and Korea (FET =12, $p<0.05$)



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