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ICT Use and Achievement in Three European Countries: what does PISA tell us?

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ABSTRACT During the last decade, in many European countries large investments were made to foster the use of information and communication technology (ICT) in education with the expectation that ICT would make teaching and learning more effective. This would, for example, become evident in scores obtained by students in the Programme for International Student Assessment (PISA). PISA studies show, however, that PISA achievements do not increase with ICT use. The question for research is why high-frequency ICT use tends to be related to lower PISA achievements. To answer this question, the author has looked at PISA results published by the Organisation for Economic Co-operation and Development (OECD) as well as at the results of his own analyses of PISA data. While it seems that ICT use as well as PISA achievements are related to cultural capital, the findings are not clear-cut and vary among the three European countries chosen for investigation.

Introduction

During the last decade, digital competence was named as a twenty-first-century key competence by various organisations (e.g. World Bank, 2003; European Council, 2006). Also, large sums of money were invested in many countries to foster the use of ICT in education. The expectations were that (1) schools would equip their students with ICT skills; (2) schools would bridge the digital divide; and (3) ICT would make teaching and learning more effective (OECD, 2010).

It is certainly important to ask whether these expectations have been fulfilled. One way to approach this question is to look at PISA results. The Programme for International Student Assessment (PISA) was initiated by the Organisation for Economic Co-operation and Development (OECD) in 2000. Since then, fifteen-year-old students have been tested in a large number of countries every three years. During the last decade, the number of OECD countries participating in the PISA studies increased from 28 to 34, and the number of non-OECD countries participating in the study increased from 4 to 33. While PISA assesses competences in the fields of reading, mathematics and sciences, each time the focus was on one of these three fields. Based on the expectations mentioned above, it is hypothesised that increased ICT use results in better or higher PISA results.

The most recent PISA results (PISA 2009 – see OECD, 2010) show that in many countries, students are accustomed to the computer, and in some countries a large majority of students indicate that they have been using the computer for more than five years. Countries where more than 70% of the students indicate that this is true are Australia, Canada, Korea, Norway, Sweden, Denmark and the Netherlands. There is, however, a large difference between computer use at home (more than 80% in PISA 2006) and computer use in school (less than 60% in PISA 2006). I will therefore look at these two environments separately. In the 2006 PISA survey, there were also large differences between Germany, Finland and the Netherlands in terms of computer use at school. I therefore explored ICT use in these countries as it was recorded in the 2009 PISA study.

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Theory

Looking at the time, energy and money that have been invested in the last decade to provide students with access to computers and to the Internet, it would be expected that this would result in better learning, which in turn should be visible in improved PISA achievements. However, PISA results published by the OECD show that there is not a linear relationship between ICT use and PISA results. It is probably difficult to exactly tell why this is the case, but one idea that came to my mind as I was exploring this issue is that there is indeed no causal relationship between ICT use and PISA achievements. Rather, I expect that ICT use as well as PISA achievements are influenced by students' family environments, and this reminded me of Bourdieu's concept of cultural capital. Bourdieu (1986) distinguished between several forms of capital: economic, cultural and social capital. While economic capital may be transformed directly into money, this is not the case for cultural and social capital. Nonetheless, they are important for people's social status and their access to society's resources.

Basically, cultural capital refers to people's investments and returns in education. Bourdieu proposed the concept of cultural capital to explain differences in scholastic achievements of students coming from different social classes in France. According to Bourdieu, three forms of cultural capital can be distinguished: (1) embodied cultural capital (basically the cultural content and the knowledge one has acquired as a result of learning, for example); (2) objectified cultural capital (cultural goods like books, pictures, machines); and (3) institutionalised cultural capital (e.g. the degrees one has obtained in school and further studies). I would therefore argue that students from families which are well endowed with cultural capital will perform better in school and will also do better in PISA surveys, while students from families with low cultural capital will not do well, either in school or in PISA surveys. At the same time, I would venture the hypothesis that high ICT use will be found more often in these families.

Method

This work is a result of a desktop analysis. I first searched OECD publications as well as related works. The results reported in sections 4.1 to 4.4 are based on this research. The results described in sections 4.5 to 4.7 are based on my own analysis of data from the PISA 2009 survey (available at pisa2009.acer.edu.au) using SPSS version 19. In particular, I analysed data from Germany, Finland and the Netherlands.

Results

Computer Use at School

Figure 1 shows how computers were used in school according to the PISA 2009 survey (OECD, 2011, p. 165). While there are some differences between the different subjects, overall computer use in class is relatively low. Not more than 25% of the students report that they use a computer during regular classroom lessons at least sometime during the week.

Computer Use at Home

As Figure 2 shows, according to the 2009 PISA survey, computers were used at home for a wide variety of activities and with relatively high frequency (OECD, 2011, p. 158).

Using the computer for school-related activities was definitely much less popular with young people, as shown in Figure 3 (OECD, 2011, p. 160).

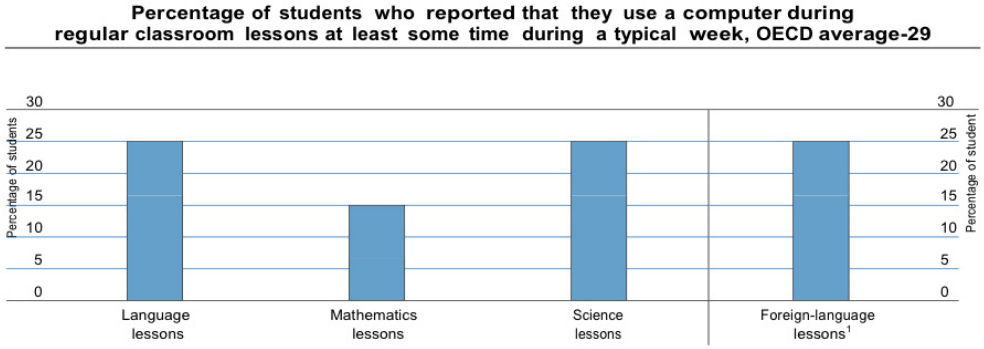

Figure 1. Computer use at school (in 2009, mean across PISA countries; from OECD, 2011, p. 165).

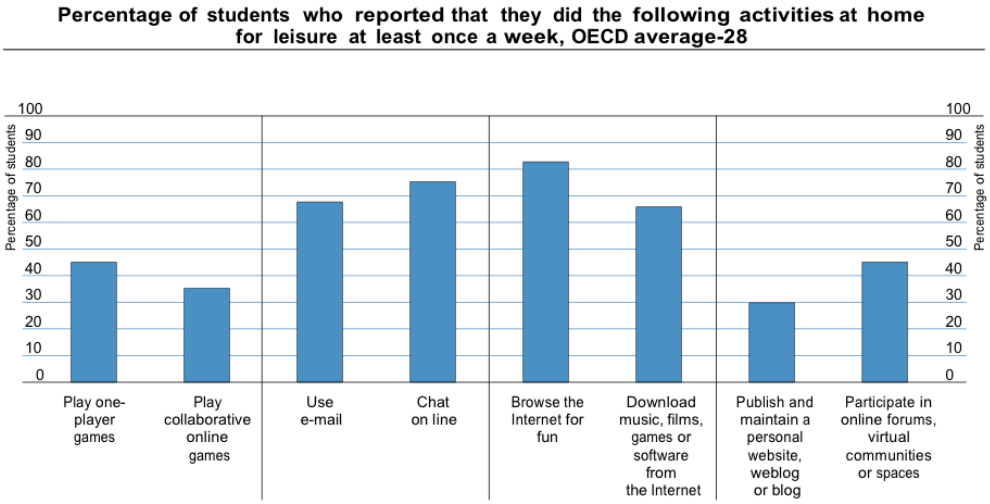

Figure 2. Computer use at home (in 2009, mean across PISA countries; from OECD, 2011, p. 158).

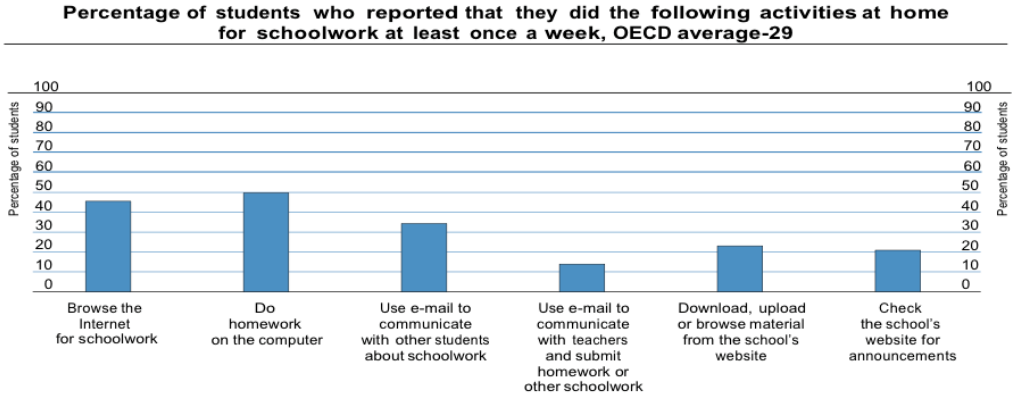

Figure 3. Computer use at home for school-related activities (2009, mean across PISA countries; from OECD, 2011, p. 160).

Computer Use and PISA Achievements

The relationship between computer use and PISA achievements is not a linear one. Low ICT use as well as high ICT use tend to be related to low PISA achievements. Put differently, up to a certain

point PISA achievements go up with increased ICT use, while beyond that point PISA achievements go down as ICT use increases further. This is true for ICT use for leisure activities as well as for school-related activities: see Figures 4 and 5 (OECD, 2011, pp. 181, 184).

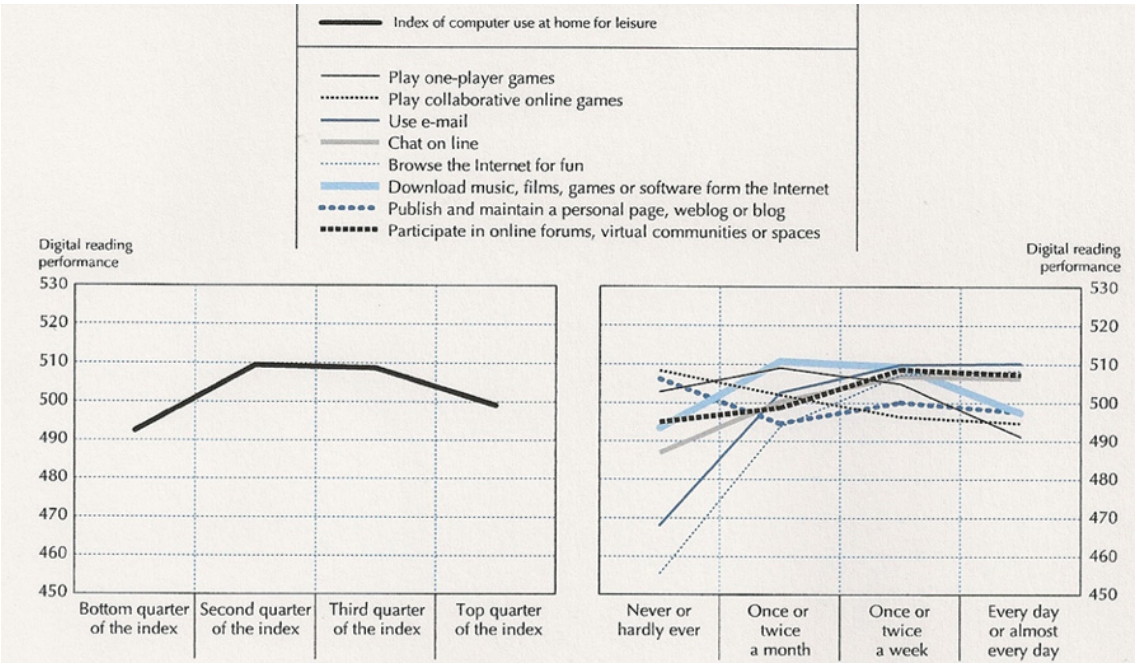

Figure 4. Computer use at home for leisure activities and digital reading performance, PISA 2009 (from OECD, 2011, p. 181).

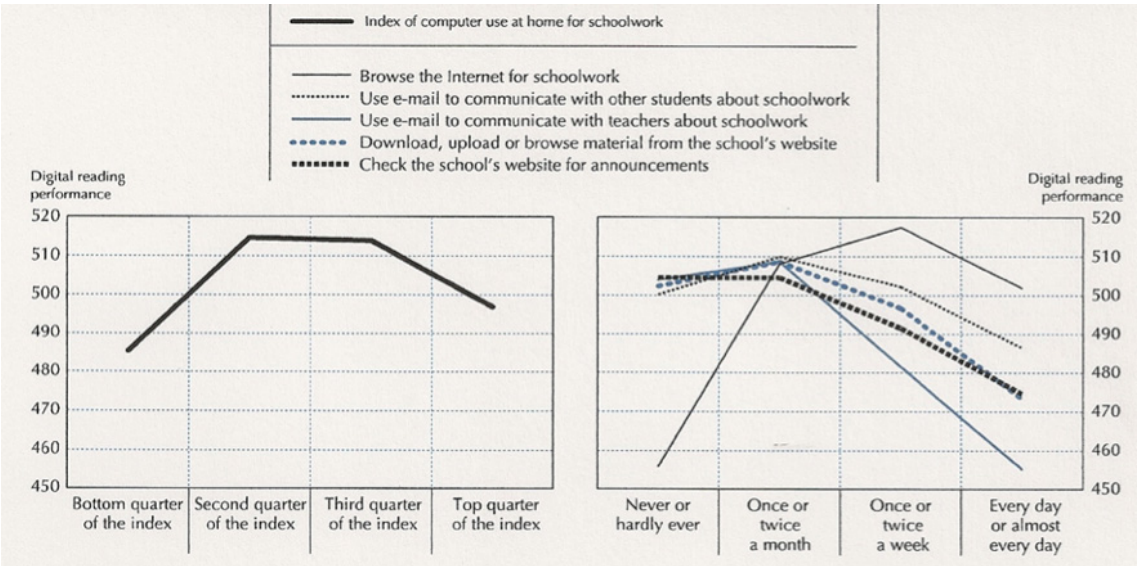

Figure 5. Computer use at home for school-related activities and digital reading performance, PISA 2009 (from OECD, 2011, p. 184).

The following question therefore arises: does high ICT use impair PISA achievements? Or, put somewhat differently, who are the high-frequency ICT users?

High-frequency ICT Users: who are they?

There are a few studies that might shed light on this question. One of these is a study conducted in Germany by the Kriminologisches Forschungsinstitut Niedersachsen (Criminological Research Institute Lower Saxony) (Pfeiffer et al, 2007). These authors analysed results from PISA 2000 and 2003 and found that, in Germany, there are four groups of students who tend to score low in PISA: (1) boys (versus girls); (2) students from the north of Germany (versus those from the south of Germany); (3) students from families with low socio-economic status (versus students from families with high socio-economic status); and (4) students with a migration background (versus students without a migration background). These groups were called PISA losers.

While these differences are often attributed to failures of the educational system, Pfeiffer et al (2007) argue that they might also have to do with the family background of the students and, in particular, with their media use. In order to explore this hypothesis, they conducted a study with some 6000 fourth-graders and 17,000 ninth-graders who were given questionnaires related to their home environments and their habits of media use. Interestingly, there was a greater extent of media use in those groups that showed the same characteristics as the PISA losers. Already at the age of ten, children in these disadvantaged groups (boys, living in northern Germany, from families with low socio-economic background, with a migration background) show remarkable differences in their media use in comparison with their counterparts in the advantaged groups (girls, living in southern Germany, from families of high socio-economic status, with no immigration background). In the disadvantaged groups, a greater percentage of children have a TV set, a video games console or a computer in their room, and use these media more frequently, than in the advantaged groups. They also watch videos which are not suited for their age and videos exhibiting violence more often than their advantaged counterparts. At the same time, children of the disadvantaged groups have a much smaller chance of being successful in school than their advantaged counterparts.

It is very tempting to explain the difference between the disadvantaged and advantaged groups by pointing to the differences in media use, and this is, in fact, what Pfeiffer et al (2007) suggest. This explanation has a high degree of plausibility because high-frequency media users probably have less time to do their homework. It may also be argued that viewing videos exhibiting violence is emotionally arousing and that emotional arousal may impair ongoing learning processes. While the interpretation Pfeiffer et al (2007) present is certainly plausible, it is not the only plausible one. It is at least as plausible to assume that something like family background or family culture might be the real causal variable which influences media use and success in school. I was therefore interested to see whether PISA results could provide us with some answers.

High-frequency ICT Users: computer at home versus video games console

Before I go into details, I would like to point out that PISA results to some extent substantiate the claims made by Pfeiffer et al (2007) concerning the students they called PISA losers. Across PISA countries, girls do better than boys, students from families with high educational levels of parents do better than students from families with low educational levels of parents, and native students do better than students with a migration background.

In order to get an idea about who the high-frequency ICT users might be, I would like to look at PISA results from Germany, Finland and the Netherlands. The results from the PISA 2006 testing period showed that the use of ICT in schools was particularly low in Germany; only 31% of the respondents indicated that they used ICT in school. The Netherlands seemed to be the country with the highest ICT use in school (85%), while Finland – the country which always does very well in PISA surveys – was somewhere in the middle as far as its use of ICT in school is concerned (51%). Somewhat similar figures were obtained when looking at ICT use at home, although ICT use at home was in general higher than ICT use in school. In the 2009 PISA survey, there were hardly any differences between these three European countries; in each of these countries, more than 90% of the respondents indicated that they used computers in school as well as at home. The rank order of the three countries concerning computer use at home was still the same, but at the same time, computer use at home no longer seemed related to PISA achievements.

It was, however, extremely difficult to find the desired information on high-frequency ICT users in Germany, Finland and the Netherlands. OECD publications do not address this issue. However, the website for PISA data (pisa2009.acer.edu.au) does allow users to ask for specific kinds of cross-tabulations, which I used to indirectly shed some light on the issue of high-frequency ICT users. The data provided in Tables I and II were obtained from cross-tabulations provided by the website pisa2009.acer.edu.au.

Computer at home	Yes, I use it	Yes, but I don't use it	No
Germany	92%	2%	3%
Reading	507	515	492
Mathematics	522	517	492
Science	531	529	504
Finland	77%	10%	11%
Reading	535	552	549
Mathematics	541	544	543
Science	554	561	560
Netherlands	97%	2%	1%
Reading	512	536	474
Mathematics	530	544	487
Science	528	549	488

Table I. Computer use at home and PISA achievements
(from PISA 2009 data, cross-tabulation provided by pisa2009.acer.edu.au).

The 2009 PISA survey included a questionnaire on ICT use which was optional and was not given in all the PISA countries. The questionnaire was, however, given to students in Germany, Finland and the Netherlands. I will focus on two questions. Question Q01 was: Is there a computer available for you to use at home? Students had three alternatives with which to answer: (1) yes, I use it; (2) yes, but I do not use it; and (3) no. Question Q04 asked about the presence of a video games console, with the same options for responses (see Table I).

It is interesting to note that, in Germany and the Netherlands, the frequency of computer use is very high (92% and 97%, respectively). At the same time, the very small group of students who indicated that they do not have a computer at home obtained lower scores in all three PISA competences (reading, mathematics, science). One might argue that families without a computer may be in the low-income group, which at the same time may turn out to be an obstacle to reaching high scores in the PISA survey. But we would certainly need more data to substantiate this claim.

In contrast to these findings, the frequency of computer use at home was much lower in Finland. At the same time, the group of students who indicated that they did not have a computer at home, or that they did not use it, did better in PISA 2009 than those students who did use a computer at home. Without additional information, these findings are difficult to interpret.

I was interested in comparing computer use with the use of a video games console. The corresponding data are presented in Table II. This time, the differences between students' responses in the three countries were smaller (the figures for those using a video games console at home being 66%, 58% and 66% in Germany, Finland and the Netherlands, respectively). However, students who used a video games console at home showed poorer PISA achievements than those students who had one but abstained from using it. It can be seen in Table II that the students who had no video games console at home scored relatively highest, in all cases. It therefore seems that although computers and video games consoles are both digital media, the relationship between ICT and PISA achievements for computer use is different from that which exists for the use of video games consoles.

Video games console at home	Yes, I use it	Yes, but I don't use it	No
Germany	66%	13%	22%
Reading	495	514	533
Mathematics	513	519	542
Science	522	530	554
Finland	58%	19%	20%
Reading	529	546	554
Mathematics	539	543	548
Science	551	559	567
Netherlands	66%	15%	19%
Reading	504	521	532
Mathematics	528	529	539
Science	524	529	542

Table II. Use of a video games console at home and PISA achievements (from PISA 2009 data, cross-tabulation provided by pisa2009.acer.edu.au).

Computer at Home, Video Games, and Family Status

The results in sections 4.6 and 4.7 were obtained from my own analysis of a selection of PISA 2009 data (pisa2009.acer.edu.au) using SPSS version 19. In the PISA questionnaire, students were asked a number of questions concerning their home environment. Based on the responses to these questions, an index of economic, social and culture status (ESCS) was computed. Basically, the index is related to (1) home possessions (including, for instance, the number of books); (2) parental occupation; and (3) parental education (number of years of schooling). The index seems to be a good operationalisation of Bourdieu's concept of cultural capital (Bourdieu, 1986); it is standardised with zero mean and a standard deviation of one. Table III shows the mean values for ESCS according to use of computer and video games console. Differences in ESCS between different user groups are highly significant ($p < .001$) unless indicated otherwise (not significant = n.s.).

Use at home	Computer	*n*	Video games console (n.s.)	*n*
Yes, I use it	.22	4070	.20	2785
Yes, but I don't use it	.27	98	.17	562
No	-.33	146	.23	964
Total mean	.21		.21	

Table III. ESCS index and ICT use in Germany.

While the absence of a desktop computer at home seems to be an indication of low cultural capital (ESCS), the absence of a video games console seems to indicate just the opposite in Germany.

Use at home	Computer	*n*	Video games console	*n*
Yes, I use it	.42	4395	.43	3365
Yes, but I don't use it	.54	623	.47	1115
No	.30	638	.35	1185
Total mean	.42		.42	

Table IV. ESCS index and ICT use in Finland.

As in Germany, in Finland the absence of a desktop computer at home is related to the lowest mean value of the ESCS index; the same is, however, true for the absence of a video games console at home.

Use at home	Computer (n.s.)	*n*	Video games console (n.s.)	*n*
Yes, I use it	.33	4468	.35	3049
Yes, but I don't use it	.40	84	.32	696
No	.10	49	.28	850
Total mean	.33		.33	

Table V. ESCS index and ICT use in the Netherlands.

In the Netherlands, the lack of a desktop computer at home is also related to the lowest mean value for the ESCS index; the same is true for the absence of a video games console. Differences between user groups are, however, statistically not significant. Across the three countries under consideration, the highest ESCS index is found in the group that does have a desktop computer at home, but does not use it. This does not necessarily mean that this is a group of non-users; it might very well be that these young people do not use the desktop computer at home because they have a laptop computer of their own. Interesting differences between countries can be observed. In Finland and the Netherlands the absence of a video games console is related to the lowest ESCS index; however, this is not true for Germany.

One final observation concerns the differences between countries with respect to the ESCS index. If we interpret this index as an operationalisation of cultural capital, then this is lowest in Germany (.21), followed by the Netherlands (.33) and then Finland (.42).

Internet Use at Home: for school or for fun

In the 2009 PISA survey, students were also asked about their acquaintance with ICT and the different uses they made of the digital media. In this last section, I would like to compare the use of the Internet for leisure-time activities and for school-related activities across the three countries under investigation and its relation to the ESCS index.

Internet use at home	For school	*n*	For fun	*n*
Never or hardly ever	-.20	589	-.24	218
Once or twice a month	.24	1993	.19	342
Once or twice a week	.30	1385	.25	1010
Almost every day	.31	317	.22	2726
Total		4284		4296

Table VI. ESCS index and Internet use in Germany.

Internet use at home	For school	*n*	For fun	*n*
Never or hardly ever	.18	1212	-.08	100
Once or twice a month	.45	3363	.40	257
Once or twice a week	.59	881	.43	1103
Almost every day	.61	193	.43	4221
Total		5649		5681

Table VII. ESCS index and Internet use in Finland.

As can be seen in Table VI, in Germany the ESCS index increases as Internet use increases; this is true to a greater extent for school-related Internet use than for using the Internet for fun. As for school-related Internet use, those students who indicate that they use the Internet for that purpose constitute a clear minority. With respect to Internet use for fun, students indicating that they use the Internet for that purpose constitute the majority. A similar pattern emerges in the Finnish

sample (see Table VII) and in the Dutch sample (Table VIII); however, the Dutch data set did not contain any data on Internet use for fun.

Internet use at home	For school	*n*
Never or hardly ever	-.00	371
Once or twice a month	.31	1751
Once or twice a week	.39	1752
Almost every day	.39	714
Total		4588

Table VIII. ESCS index and Internet use in the Netherlands.

Conclusions

Several analyses of PISA data show that there is no linear relationship between ICT use and achievement in PISA. In fact, the relationship between the two variables seems to follow an inverted U-curve. That is, while up to a certain amount of ICT use, PISA achievements increase in proportion to ICT use, PISA achievements go down as ICT use increases beyond this critical point. In my contribution, I have tried to find out why this should be the case. While I first looked at data that were published by the OECD and at the results of its analyses of these data, I did my own analysis of the 2009 PISA data. In particular, I looked at data from Germany, Finland and the Netherlands. While analysing these data, I developed the hypothesis that what Bourdieu called cultural capital might be a key factor in explaining the relationship between ICT use and PISA achievement. More concretely, I assumed that cultural capital influences ICT use as well as PISA achievements. Of course, it is difficult to show that cultural capital is indeed a cause of ICT use and PISA achievement, even if we applied regression analysis or more elaborate mathematical models like linear structural relation models. In order to do this, we would need at least longitudinal data or data from experimental designs.

When we look at ICT use, it is important to distinguish between different forms of ICT use. Using a computer, for instance, does not have the same meaning as using a video games console. As the PISA 2009 data show, a large majority of students have a computer at home which they also use. To a much lesser extent, this is also true for the use of video games consoles. Although the group of non-users is very small, the data suggest that it does make a difference whether students do have, or use, a computer or a video games console at home. Computer use at home seems to be positively related to PISA achievements, while the use of a video games console seems to be negatively related to PISA achievements. At the same time, the absence of a computer at home corresponds to a lack of cultural capital as operationalised through the ESCS index. This is true for Germany, Finland and the Netherlands. In contrast, the absence of a video games console corresponds to a high degree of cultural capital in Germany and in the Netherlands, but not in Finland. Frequent use of the Internet for school-related as well as for leisure-time activities seems to be positively related to cultural capital.

In order to be able to specify the degree of relationship or correspondence in terms of covariance or correlation, we would need the categories of the use of the digital media to be more fine-grained.

The interesting fact is that there are clear differences in ESCS levels between countries. It might be argued that the mean ESCS level of a country can be considered to be an indicator of its educational culture, which values the different uses of digital media in specific ways. At the same time, it is also important to look at families. While I do believe that cultural capital is an important aspect of families, I would prefer to talk of family cultures, of which cultural capital is only a part, albeit an important one. It therefore does not make much sense to talk about ICT use in general. We need to have a much closer look at what kind of ICT equipment is being used and exactly how it is being used and in which country and in which kind of family culture. A much more differentiated approach might help us to understand which ICT-related activities tend to be correlated with socio-demographic indicators, on the one hand, and with PISA achievements, on the other, in European countries.

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