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The Relationship between Educational Inequalities and ICT Access and Use at Home

Abstract

The appearance of info-communication technologies caused a restructuring in the determining factors of educational inequalities. The aim of our article is to analyse the effect of ICT access and ICT use at home on student performance. For our analysis we apply the Hungarian subsample of the latest student-level dataset of the OECD Programme for International Student Assessment (PISA) recorded in 2012. As we suppose that the relationship between ICT access, ICT use and student performance is affected by family background and student characteristics, beyond bivariate analysis we apply multivariate models to control for these effects. Our results suggest that the impact of ICT access and ICT use on student performance is rather positive even if family background and student characteristics are controlled for. However some modes of use seem to have rather a negative effect on performance.

Keywords educational inequalities, ICT access, ICT use, student performance

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1. Introduction

An important feature of education and the institution of school should be the moderating of inequalities among students by transmitting knowledge and skills indispensable in later life. However many scholars pointed out that school does not reduce inequalities among students but even strengthens them (e.g. Bourdieu 1974). The background of educational inequalities, the exploration of factors affecting differences in school performance has been in focus of many theoretical works and researches for a long time. Traditionally academic achievement is found to be mostly influenced by family background, namely socio-economic status, educational level of the parents, cultural capital in the family and so on. In Hungary in the 1970's Ferge (1980) drew attention to the fact that contrary to the ideological concept school does not diminish the differences among students from different social background but sustains them and even intensifies them (Ferge 1980). There has been not much change in this correlation recently, as international researches report Hungary to be one of those nations where the effect of social background mostly determines school performance (Vári 2003). In Hungary the biggest proportion of students from a disadvantaged background, where parents have a low socio-economic status and low educational level, belong to the group of students with lowest competencies (Róbert 2004).

With the appearance of info-communication technologies the traditional structure of factors influencing school performance has restructured (Ben-David Kolikant 2010). As ICT has become more and more available and used inside and outside of school we have to take in account its effect on learning and academic performance to reveal its role in educational inequalities. In the last decade ICT competencies have become a very important feature on the labour market and in everyday life as well. According to the growing importance of computer skills and digital literacy in society schools have been pushed by education policy internationally and in Hungary as well (Tóth – Molnár – Csapó 2011) to integrate ICT more and more in the school's infrastructure on the one hand and in the way of teaching and learning on the other hand. An important question sociologists have to deal with is what effect the integration of ICT in education has on educational inequalities? More precisely: in which way do the access and use of computers and the internet inside and outside of school influence student performance? The aim of our article is to answer one part of this question, namely: what effect does ICT access and use at home have on school performance in terms of mathematics, reading and science skills and knowledge? Two hypotheses can be drawn up regarding this issue. The first one assumes that the access and the use of ICT weaken school performance because these devices distract attention from learning and the unsuitable use sets back learning. However due to the other assumption ICT access and use enhance performance because ICT makes knowledge accessible for everyone and by its interactive, visual, collaborative features brings learning closer to the generation of 'digital natives'.

In the last decade many researches have addressed the correlation between dimensions of ICT access, ICT use and school performance. The results are contradictory and confusing as some of them found a negative relationship but others revealed rather a positive correlation.

In the first section we give an overview on the latest findings either positive or negative on the relationship between ICT access and/or use and academic performance. The next section presents in detail the data and methods applied for our analysis. Results are demonstrated in the third section. Finally in the conclusion the initial research question is addressed again in the light of the results of our analysis.

2. Info-communication technologies and school performance

Due to the growing penetration of ICT at home and at school, its effect on learning and academic achievement has become an important research issue. Another reason for scholars focusing on students' use of ICT and its effects is that this generation has been proclaimed a new generation of digital natives (Prensky 2001) whose socialization differs basically from the previous generations as they grew up surrounded by computers, mobile phones and the internet.

Some studies found a rather positive correlation between dimensions of ICT use and school performance. Eynon – Malmberg (2011) investigated the modes of internet use and its effect on learning among children and youngsters. The survey was conducted in Great-Britain among respondents 8, 12, 14, 17 and 19-years old. The questions concerned despite socio-demographic issues, ICT use and knowledge, attitudes towards ICT and quality of access. According to the results, four user profiles have been separated: peripherals, normatives, all-rounders and active participators. Peripherals tend to use the internet less as most of them do not have access at home. Normatives use the internet primarily for communication, entertainment and to gain information but they are not involved in creative and participatory activities on the internet. All-rounders do all kind of activities on the internet as for active participators are mostly involved in participatory activities. Authors conclude that all modes of internet use can contribute to learning and a better school performance in different ways if teachers are aware of the user profiles and the ICT skills of students. Similarly Jackson et al. (2010) found also a positive correlation between some aspects of ICT use and school performance. This longitudinal research in the USA intended to explore the effect of internet use and playing video games among 12-year old children. Results implied that reading skills were improved by internet use and video games if this skill had been below the average. However ICT use had no significant effect if reading skills had been above average. Authors point out the complexity of this relationship: socio-demographic factors have to be considered as they influence both dependent and independent variables in this case.

The Programme for International School Assessment of the OECD allows for diversified exploration of factors influencing school performance. As the survey includes an ICT questionnaire to reveal the extent of ICT access at home and at school and modes of ICT use, many scholars explored the relationship between ICT use and student performance. Analysing PISA data Anil and Ozer (2012) found a positive correlation between science skills and ICT access and use in Turkey in 2006. Computer and Internet availability at home and at school increased the achievement points on the science tests. The advanced use of ICT (using excel, use of educational software, etc.) also enhanced science skills and knowledge, but the use for entertainment had rather a negative effect on achievement. International analysis also confirmed the positive relationship between ICT use and performance. Based on PISA data from 2006 Spiezia (2011) revealed a positive impact of ICT use on science scores even after controlling for students' characteristics and family background. Nevertheless a distinction between the effect of ICT use at home or at school had been revealed. The effect turned out to be larger when computer was used at home rather than at school. In most countries computer use at school did not have a significant impact on science performance. Results from the assessment in 2009 also indicated a positive effect of ICT use on school performance. Delen – Bulut (2011) analysed the impact of students' exposure to technology and their familiarity with ICT on math and science performance in Turkey. Access and use of ICT at home had a larger impact on students' math and science scores than ICT use at school.

Besides the positive relationship between ICT use and performance some studies found rather a negative correlation. Fuchs – Woessmann (2004) pointed out that although bivariate analysis shows a positive correlation, multivariate investigation reveals a negative impact. In their study exploring the effect of ICT access and use on student performance applying PISA data from 2000, the initial positive effect turned into a negative one when possible influencing factors as student characteristics, family background and school characteristics were controlled for. In their study Mominó – Meneses (2007) also emphasized that the positive relationship between ICT use and student performance might be confusing as it just reflects the effect of a privileged family background. Therefore they claim that Internet use itself does not lead to a better school performance. Moreover a proper use of ICT in favour of learning is not the reason for but the consequence of a good academic performance.

The literature concerning the effect of ICT use on learning and school performance is somewhat contradictory as both positive and negative correlation has been revealed. Based on previous researches and results we hypothesize that the relationship between ICT access, ICT use and student performance is rather positive. However this correlation has to be investigated more in detail by taking into consideration other factors and effects that can influence this relationship, e.g. family background and student characteristics. Only after controlling for these variables can we tell something real about the effect of ICT use on learning and performance.

3. Data and methods

To investigate the relationship between ICT availability, ICT use and school performance, we use the latest student-level dataset of the Programme for International Student Assessment (PISA) recorded in 2012. This huge, extensive international survey aims to evaluate education systems by testing student skills and knowledge in three main fields: mathematics, reading and science with a focus on one every three years since 2000 when the first survey was conducted. In each participating country[1] a random sample of the population of 15-year old students is involved in the survey from randomly selected schools. The main survey is supplemented among others[2] by an ICT questionnaire which gathers information about ICT access and use inside and outside of school. Throughout the five assessments so far from the year 2000, the ICT questionnaire went through some modifications and extensions. For this reason longitudinal analysis and comparison are limited. Our analysis is based on the Hungarian dataset as we focus on the Hungarian case regarding the impact of ICT use on student performance. The Hungarian sample comprises 4810 students from 204 schools. Analysis was undertaken on weighted data using the final student weight (OECD 2009. 36.).

[1] In 2012 the following 65 economies took part in the test: Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Chinese Taipei, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic , Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong-China, Hungary, Iceland, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kazakhstan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Macao-China, Malaysia, Mexico, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Qatar, Republic of Montenegro, Republic of Serbia, Romania, Russian Federation, Shanghai (China), Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Thailand, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States, Uruguay, Vietnam.

[2] The PISA assessment also includes a questionnaire for school principals who provide information about the schools' composition regarding students and teaching staff and also the teaching and learning environment of the school.

The PISA database includes several measures of computer availability and use both at home and at school. First we show bivariate evidence on the relationship between ICT access, ICT use and student performance in mathematics, reading and science. Relying on previous empirical works we suppose that other factors may have an impact on this relationship. Therefore multivariate analysis is applied to reveal the net impact of ICT access and use on achievement, by controlling for substantial variables that are assumed to influence the relationship between computer use and performance. In this section we build on linear regression models.

The dependent variables (Table 2.) in our analysis are measures of student performance in mathematics, reading and science. As the participating students in the survey fill out different combinations of different tests, the achievement scores are estimated by five plausible values in each field.[3] On large samples using one plausible value or five plausible values does not make a substantial difference between mean estimates and standard error estimates (OECD 2009. 44.). Therefore in our analysis we use the first plausible value of mathematics, reading and science achievement.

For both bivariate and multivariate analysis we explore first the relationship between ICT access and student performance and afterwards the impact of ICT use on achievement[4]. ICT access is measured in two different ways in the PISA survey in 2012. In the main student questionnaire respondents are asked about their home possessions among them computer availability for schoolwork and a link to the Internet. Thus these variables give information about computer access and Internet availability at home in a dichotomous way. However according to these variables we do not know whether the respondent uses them or not. Therefore in the analysis we included another measure of ICT access which reflects whether computer and Internet at home are used or not. We applied some transformation of the variables recorded in the ICT questionnaire to get a dichotomous variable. In the ICT questionnaire students give information about ICT devices available for them to use at home including desktop computer, portable laptop or notebook, tablet computer and Internet connection. As the answers possible were 'Yes, and I use it', Yes but I do not use it' and 'No' we transformed this scale into a dichotomous scale reflecting whether the device is used or not.[5] The first dummy variable (COMPUSE) includes use of desktop computer and/or portable laptop and/or tablet. In this sense we regard for instance the use of a tablet computer equal to the use of a desktop computer. The second dummy variable (NETUSE) measures the use of Internet connection[6].

To reveal broader correspondences we were not only interested in the relationship between the dichotomous measures of ICT access, ICT use and student performance but the correlation between the way of ICT use and achievement. The PISA ICT questionnaire included a set of items referring to the purpose of computer and Internet use. The students reported the frequency of use on each item[7]. In our analysis we used principle components based on these items (TABLE 1.). Three principle components were separated. The first (ENTCOM) refers to a frequent use of entertainment and communication activities on the computer and the internet except playing

[3] The concept of using plausible values instead of other measuring methods is explained in detail in OECD (2009): PISA Data Analysis Manual: SPSS, Second edition.

[4] ICT access is considered both the availability (possession) of a computer and internet connection, and the use of these devices in a dichotomous sense (uses or does not use). Under ICT use we mean the purpose of use.

[5] The items were recoded as following: 'Yes and I use it'=1, 'Yes but I do not use it'=0, 'No'=0.

[6] Recoded the same way: 'Yes and I use it'=1, 'Yes but I do not use it'=0, 'No'=0.

[7] The answer categories were: 'Never or hardly ever'; 'Once or twice a month'; 'Once or twice a week'; 'Almost every day', 'Every day'.

games. The second one (PRACT) shows the frequent use of ICT for practical purposes. Finally the third principle component (PLAY) stands for a frequent use of playing games.

1. Table: Rotated component matrix of the principle components based on items of computer use

Items	Principal component		
	1.: Entertainment/ Communication (ENTCOM)	2.: Practical use (PRACT)	3.: Playing games (PLAY)
Social networks	0,822		
Browse the Internet for fun	0,787		
Chat online	0,749		
Download music	0,623		
Upload content	0,425		
Obtain practical information from the Internet		0,857	
Read news		0,842	
Use email		0,510	
Collaborative games.			0,858
One-player games			0,856

We hypothesize that both ICT availability and the way of use are related to student performance. Based on the literature we presume a positive impact of both ICT availability and use on performance. However we believe that these effects are influenced by other factors which moderate the initial (bivariate) correspondences. Therefore we do multivariate analysis based on regression models. There are different factors expected to influence access and use. We presume that computer access is affected by the students' family background, more precisely the socio-economic and cultural status of the parents. To test this hypothesis in the regression model we include controlling variables for the family wealth (WEALTH), the educational status of the parents (HISCED) and the cultural background indicated by the cultural possessions of the family (CULTPOS). The index of family wealth (WEALTH) is based on household assets which are believed to capture wealth better than income. The index of cultural possessions takes account of classical literature, books of poetry and works of art at home (OECD 2014. 316.). The parental education was classified using ISCED (International Standard Classification of Education) to ensure international comparability. As a controlling variable in our analysis we use the index reflecting the higher ISCED level of either parent (OECD 2014. 307.).

As for the way of using ICT we suppose that rather student characteristics are affecting it and therefore these characteristics might influence the effect of ICT use on performance. However in the regression models only one student characteristic, namely gender[8], was included as control variable because the sample comprises respondents who are the same age.[9] We believe that boys and girls use other features of ICT and therefore the effect of use on performance may partly reflect these gender specific differences. Not just for ICT access but for ICT use family background is regarded an important factor, therefore we control for these variables as well.

Table 2. and Table 3. present descriptive statistics on the dependent variables and independent variables applied in the analysis.

[8] The gender variable was recoded: 0=Female 1=Male

[9] The PISA survey addresses 15-year old students, however the month of birth is also taken into account therefore the age of the Hungarian respondents ranges from 15, 25 to 16, 25.

2. Table: Descriptive statistics on dependent variables

	N	Minimum	Maximum	Mean	Std. deviation
Mathematics score (PV1MATH)	4810	144,19	789,69	485,39	91,34
Reading score (PV1READ)	4810	145,94	739,90	496,65	88,50
Science score (PV1SCIE)	4810	181,59	782,49	502,31	88,23

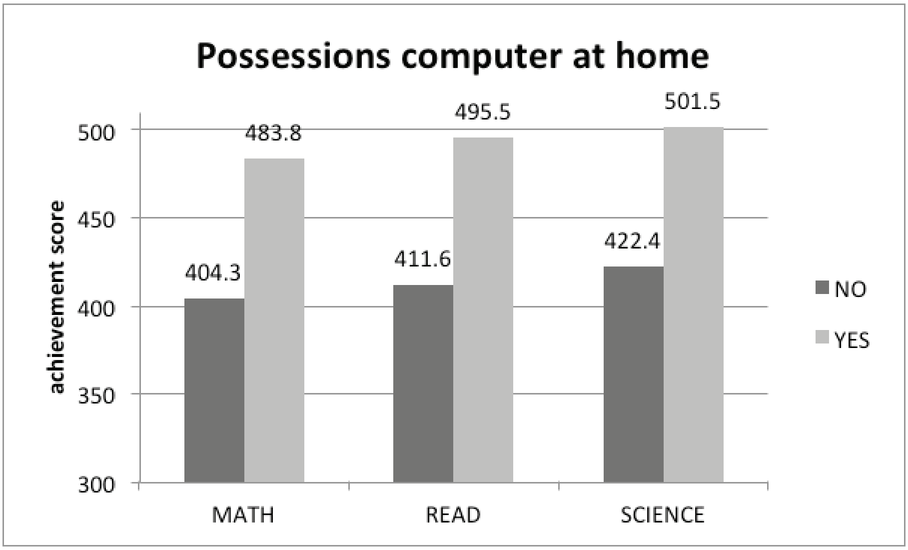
3. Table: Descriptive statistics on independent variables

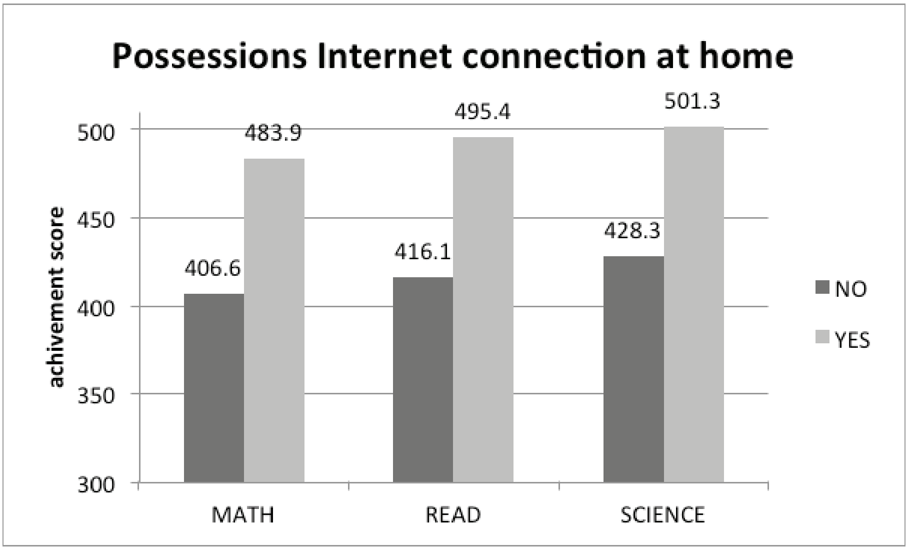
		Frequency	Valid percent
Possessions computer at home (N=4745)	Yes	4512	95,1
	No	233	4,9
Possessions internet at home (N=4754)	Yes	4499	94,6
	No	255	5,4
Uses desktop computer/laptop/tablet at home (N=4593)	Yes	4396	95,7
	No	197	4,3
Uses internet at home (N=4630)	Yes	4329	93,5
	No	301	6,5

4. Results

4.1. Bivariate evidence on computer access, Internet access and student performance

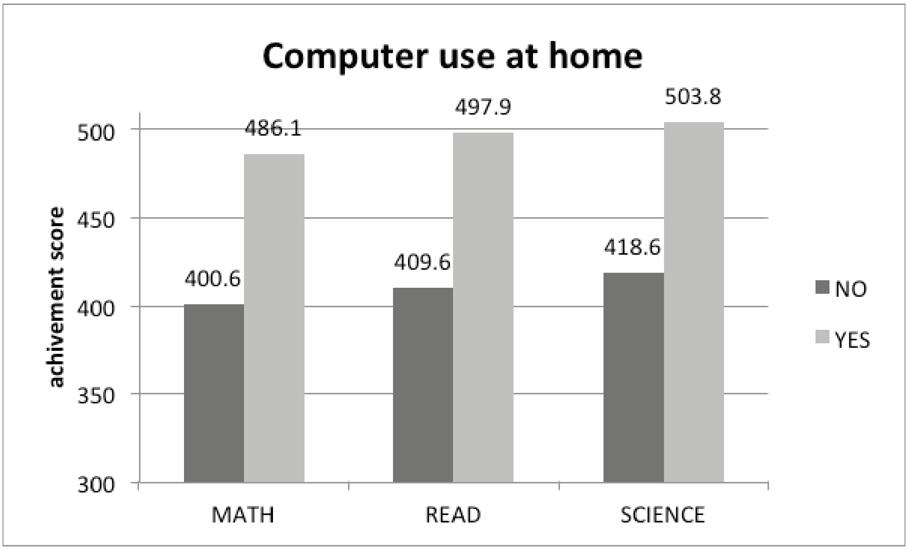
Testing for the relationship between computer and Internet availability at home and the achievement scores in mathematics, reading and science we find a positive correspondence.

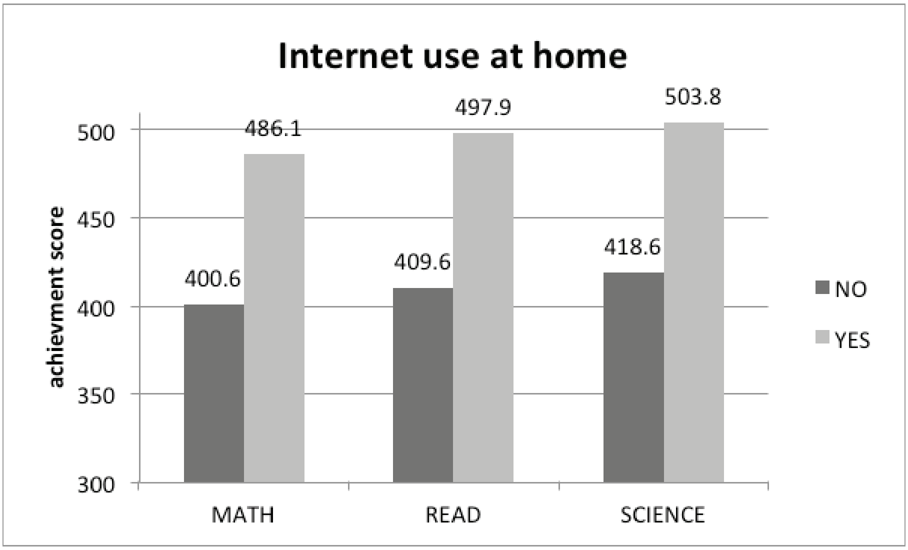




Those students who dispose of a computer or Internet at home perform better in all three fields of skills and knowledge than those who do not have a computer or Internet at home. Thus ICT environment at home enhances the academic achievement.

If we consider not only the availability - that is to say whether one disposes of a computer or Internet – but the use in terms of using the ICT devices or not, we get a very similar result.





Students who dispose of a computer – equal if it's a desktop computer, a portable laptop/ notebook, or a tablet computer – and use it, achieve higher scores on each test than those who do not use a computer regardless of whether they do have one at home or not. Internet use has the same effect, it increases performance in all three fields of skills and knowledge.

4.2. Bivariate evidence on ICT use and student performance

The purpose of ICT use indicated by principle components is related to student performance as in all fields of tested skills and knowledge the correlation is significant.

4. Table: Correlation matrix for student performance and ICT use

	ENTCOM	PRACT	PLAY
MATH	0,007*	0,106**	-0,075**
READ	0,077**	0,102**	-0,204**
SCIENCE	0,038**	0,128**	-0,079**

Notes: Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

In case of ICT use for entertainment/ communication and practical use the correlation is positive. Thus chatting, participating in social networks, browsing the internet for fun, downloading and uploading contents somewhat increases performance, mostly reading performance and least of all mathematic performance. Practical use of the internet as obtaining practical information, reading news and e-mailing shows a stronger correlation with performance than the use for entertainment or communication. Playing games however is negatively correlated to performance, hence students who use the computer and the internet to play games achieve lower scores on the assessments. Mainly reading skills are negatively affected by the use of ICT for playing games.

4.3. Multivariate evidence on computer access, Internet access and student performance

Bivariate analysis indicates a positive relationship between ICT access and academic achievement. However this relationship might reflect the effect of other factors. For instance family background influences both performance and ICT access. Students with an advantaged socio-economic background tend to perform better in school. At the same time ICT access is more probable in privileged households. Also cultural capital might be an indicator that affects both ICT access and academic performance. Higher educated parents provide more inputs for their children's learning that's why these students perform better in education. The educational level correlates positively with ICT access as well. Another indicator of cultural capital is cultural possessions at home which we presume to affect both performance and ICT access. The advantaged cultural environment in terms of cultural possessions enhances learning and knowledge as well as the probability of ICT access at home.

Therefore in the next section we try to control for these factors to reveal the net effect of computer and Internet access on educational achievement. The controlling variables were included step by step in the linear regression models to follow up the changes of effects.

In all three fields of knowledge - math, reading and science – the effect of computer availability stays positive regarding the test scores after controlling for family background variables but diminishes as the control variables are included one by one.

5. Table: Computer availability at home and student performance in math

	I.	II.	III.	IV.
Constant	*404,33*	*429,68*	*337,42*	*365,61*
Possessions computer at home	**79,48**	**61,90**	**51,93**	**45,26**
WEALTH	-	16,42	4,05	(0,46)
HISCED	-	-	21,46	15,20
CULTPOS	-	-	-	27,02
R^2	*0,041*	*0,058*	*0,15*	*0,225*

Notes: Dependent variable: Mathematics test score (PV1MATH). Significance level: 5 percent. Put in parentheses if not significant.

6. Table: Computer availability at home and student performance in reading

	I.	II.	III.	IV.
Constant	*411,61*	*429,55*	*349,98*	*381,15*
Possessions computer at home	**83,88**	**71,44**	**62,83**	**55,03**
WEALTH		11,62	0,78	-3,09
HISCED			18,52	11,69
CULTPOS				30,28
R^2	*0,048*	*0,057*	*0,128*	*0,231*

Notes: Dependent variable: Reading test score (PV1READ). Significance level: 5 percent.

7. Table: Computer availability at home and student performance in science

	I.	II.	III.	IV.
Constant	*422,39*	*445,00*	*359,52*	*389,14*
Possessions computer at home	**79,10**	**63,42**	**54,14**	**47,07**
WEALTH		14,64	3,06	-0,74
HISCED			19,88	13,30
CULTPOS				28,53
R^2	*0,044*	*0,059*	*0,145*	*0,238*

Notes: Dependent variable: Science test score (PV1SCIE). Significance level: 5 percent.

In each table Column I. shows the effect of computer availability at home on the test scores without controlling for any other impact. As in the previous section, we found that students with a computer access at home achieve about 80 points more on the tests, than those who do not have a computer at home. When family background variables are added this advantage gets moderated. In the first step (Column II.) we controlled for the wealth of the students' family. The results implicate that family wealth has a significant effect on the correlation between computer access and performance, as in all three fields test scores lower for about 12-17 achievement points when wealth is controlled for. As a next step (Column III.) we added the educational status of the parents as a control variable. Again mean test scores in maths, reading and science reduce for about 10 points for students with a computer at home compared to the previous regression model. In the last column (Column IV.) in addition to the previous models cultural possessions are taken into account, which again lowers the effect of computer access on achievement for about 6-7 points. In conclusion we found that when filtering out the effect of a students' family background in terms of wealth, highest education of either parent and cultural possession, those who have a computer achieve on average 45,26 points more in maths, 55,03 points more in reading and 47,07 points more in science compared to those who do not have a computer at home.

Exploring the net effect of Internet access we get similar results to computer access. In all three cases of mathematics, reading and science Internet access increases mean scores even if controlled for family background variables. However the effect gets lower when adding the control variables.

8. Table: Internet availability at home and student performance in math

	I.	II.	III.	IV.
Constant	*406,636*	*433,185*	*343,702*	*371,581*
Possessions Internet connection at home	**77,23**	**57,48**	**43,98**	**38,27**
WEALTH		15,026	3,238	(-0,343)
HISCED			21,666	15,29
CULTPOS				27,267
R^2	*0,041*	*0,055*	*0,148*	*0,224*

Notes: Dependent variable: Mathematics test score (PV1MATH). Significance level: 5 percent. Put in parentheses if not significant.

9. Table: Internet availability at home and student performance in reading

	I.	II.	III.	IV.
Constant	*416,093*	*433,41*	*355,933*	*386,911*
Possessions Internet connection at home	**79,31**	**66,42**	**55,33**	**48,45**
WEALTH		9,801	(-0,505)	-4,338
HISCED			18,665	11,708
CULTPOS				30,601
R^2	*0,046*	*0,052*	*0,125*	*0,23*

Notes: Dependent variable: Reading test score (PV1READ). Significance level: 5 percent. Put in parentheses if not significant.

10. Table: Internet availability at home and student performance in science

	I.	II.	III.	IV.
Constant	*428,316*	*452,32*	*368,738*	*398,079*
Possessions Internet connection at home	**72,99**	**55,13**	**42,93**	**36,84**
WEALTH		13,586	2,499	13,444
HISCED			20,143	-1,28
CULTPOS				28,802
R^2	*0,04*	*0,052*	*0,141*	*0,235*

Notes: Dependent variable: Science test score (PV1SCIE). Significance level: 5 percent. Put in parentheses if not significant.

When controlling for all three family background variables the net effect of Internet access on performance is on average 38,27 points in maths, 48,45 points in reading and 36,84 points in science.

We hypothesize that the use of a computer or the Internet connection is also affected by family background. Therefore the effects of computer use and Internet use are also controlled for family wealth, educational level of the parents and the cultural environment, in terms of cultural possessions. The results are very similar to the results of computer and Internet availability.

11. Table: Computer use at home and student performance in math

	I.	II.	III.	IV.
Constant	*400,58*	*425,03*	*335,11*	*362,03*
Uses computer/laptop/notebook at home	**85,51**	**67,86**	**56,08**	**51,33**
WEALTH		14,41	2,446	-1,227
HISCED			21,332	14,94
CULTPOS				27,128
R^2	*0,043*	*0,056*	*0,148*	*0,225*

Notes: Dependent variable: Mathematics test score (PV1MATH). Significance level: 5 percent.

12. Table: Computer use at home and student performance in reading

	I.	II.	III.	IV.
Constant	*409,60*	*425,87*	*348,86*	*378,40*
Uses computer/laptop/notebook at home	**88,26**	**76,50**	**66,97**	**61,72**
WEALTH		9,486	-0,802	-4,861
HISCED			18,174	11,16
CULTPOS				30,442
R^2	*0,048*	*0,054*	*0,126*	*0,233*

Notes: Dependent variable: Reading test score (PV1READ). Significance level: 5 percent. Put in parentheses if not significant.

13. Table: Computer use at home and student performance in science

	I.	II.	III.	IV.
Constant	*418,65*	*439,98*	*356,96*	*385,19*
Uses computer/laptop/notebook at home	**85,17**	**69,67**	**59,05**	**53,93**
WEALTH		12,308	1,202	-2,635
HISCED			19,634	12,969
CULTPOS				28,407
R^2	*0,047*	*0,057*	*0,143*	*0,237*

Notes: Dependent variable: Science test score (PV1SCIE). Significance level: 5 percent. Put in parentheses if not significant.

The correlation between ICT use and academic performance is influenced by family background as the regression models show us. Involving control variables for family wealth, education of parents and cultural possessions reduces the effect of computer use on test scores. In the final models we find that computer use itself enhances achievement in math for 51,33 points, in reading for 61,72 points and in science for 53,93 points on average.

The regression models for the net effect of Internet use at home reflect the same tendency for all three fields of assessment.

14. Table: Internet use at home and student performance in math

	I.	II.	III.	IV.
Constant	*409,52*	*430,28*	*339,17*	*368,49*
Uses Internet at home	**77,30**	**62,71**	**52,81**	**45,55**
WEALTH		13,576	1,785	-1,581
HISCED			21,193	14,82
CULTPOS				27,072
R^2	*0,05*	*0,061*	*0,151*	*0,226*

Notes: Dependent variable: Mathematics test score (PV1MATH). Significance level: 5 percent.

15. Table: Internet use at home and student performance in reading

	I.	II.	III.	IV.
Constant	*416,23*	*428,58*	*350,84*	*382,88*
Uses Internet at home	**82,61**	**73,95**	**66,05**	**57,93**
WEALTH		8,003	-2,121	-5,765
HISCED			17,984	11,058
CULTPOS				30,166
R^2	*0,06*	*0,064*	*0,133*	*0,237*

Notes: Dependent variable: Reading test score (PV1READ). Significance level: 5 percent. Put in parentheses if not significant.

16. Table: Internet use at home and student performance in science

	I.	II.	III.	IV.
Constant	*427,17*	*444,79*	*360,67*	*391,29*
Uses Internet at home	**77,49**	**65,06**	**55,92**	**48,22**
WEALTH		11,327	(0,358)	12,927
HISCED			19,55	-3,14
CULTPOS				28,282
R^2	*0,055*	*0,064*	*0,148*	*0,24*

Notes: Dependent variable: Science test score (PV1SCIE). Significance level: 5 percent. Put in parentheses if not significant.

Regarding not just the availability but the use of the Internet at home we found that aspects of family background are important factors in this case also as the effect is reduced when adding the control variables. It can be concluded that the net effect of Internet use at home is on average 45,55 points in maths, 57,93 in reading and 48,22 in science. The effect of use is somewhat higher compared to the effect of availability.

4.4 Multivariate evidence on ICT use and student performance

Correlation between the purpose of use and academic performance indicated a significant relationship. Two of the principle components of ICT use were positively related to performance: the use for entertainment/communication and practical use. The third mode of use, the one for playing games, showed a negative correlation with achievement. Applying regression models the extent of the effect of use on each kind of skills can be revealed. Moreover these effects can be controlled for background variables. In case of the mode of use we assume that personal characteristics as gender is an influencing factor. The means of factor scores for girls and boys show a significant difference.

17. Table: Gender specific differences in computer use

		N	Mean	Std. Deviation	t-statistics	sig.(two-tailed)
ENTCOM	Female	43530	**0,131675**	0,95786	39,907	0,000
	Male	40247	**-0,14242**	1,024804		
PRACT.	Female	43530	**-0,02209**	0,962472	-6,631	0,000
	Male	40247	**0,023889**	1,038548		
PLAY	Female	43530	**-0,48146**	0,78475	-166,224	0,000
	Male	40247	**0,520736**	0,945322		

Girls tend to use the entertainment/communication function of ICT more than boys. Both practical use and playing games is less typical for girls than for boys, the discrepancy is bigger in the latter case.

Beyond the personal characteristics the relationship between the purpose of use of ICT and school performance might be affected by family background as well. We assume that the way students use their devices at home is somehow related to their socio-economic and cultural background. The correlation matrix confirms this assumption as the principal components of use show a significant correlation with family wealth, education of parents and the cultural possessions at home.

18. Table: Correlation matrix for types of computer use and family background

	WEALTH	HISCED	CULTPOS
ENTCOM	0,205**	0,015**	0,046**
PRACT	0,163**	0,123**	0,200**
PLAY	0,069**	-0,061**	-0,148**

**. Correlation is significant at the 0.01 level (2-tailed).

The use of ICT for entertainment/ communication purposes is positively correlated to all three family background variables of which wealth has the strongest correlation. Practical use is also enhanced by an advantaged family background, the correlation coefficients are even bigger than in the case of the previous type of use. Playing is positively correlated to wealth however negatively correlated to the educational level of the parents and the extent of cultural possessions at home.

Relying on the correlation between the way of use and family background, during the analysis we try to reveal the effect of family background by adding these factors in the regression models after controlling for personal characteristics.

4.4.1 ICT use 1: Entertainment/ communication

The first regression models (Column I.) show the effect of the ICT use for entertainment/ communication on each test scores. These effects are rather low, in case of mathematics not even significant. The total variance explained by only this one factor is also minimal. However results report that the frequent use of ICT for entertainment/communication increases reading achievement for about 6,14 points and science scores for 3,32 points on average. In the second models (Column II.), when gender is controlled for the effect of the use for entertainment/ communication changes most in case of reading performance. The last models regress for family background variables as well (Column III.). It seems that they are mostly relevant factors in case of reading performance. The effect of the use of ICT for entertainment/communication on reading achievement lowers for about 3 points compared to the initial model when controlling for gender and family background. The effect on mathematics and science scores shows just a modest change in the last models.

19. Table: Computer use for entertainment/communication and student performance in math

	I.	II.	III.
Constant	*483,649*	*478,363*	*406,896*
ENTCOM	**(0,676)**	**1,429**	**0,728**
GENDER		11,003	19,637
WEALTH			1,254
HISCED			14,237
CULTPOS			29,802
R^2	*0,000*	*0,004*	*0,213*

Notes: Dependent variable: Mathematics test score (PV1MATH). Significance level: 5 percent. Put in parentheses if not significant.

20. Table: Computer use for entertainment/communication and student performance in reading

	I.	II.	III.
Constant	*495,175*	*512,687*	*448,355*
ENTCOM	**6,914**	**4,42**	**3,893**
GENDER		-36,451	-27,587
WEALTH			0,736
HISCED			12,62
CULTPOS			28,572
R^2	*0,006*	*0,047*	*0,236*

Notes: Dependent variable: Reading test score (PV1READ). Significance level: 5 percent. Put in parentheses if not significant.

21. Table: Computer use for entertainment/communication and student performance in science

	I.	II.	III.
Constant	*501,35*	*498,858*	*153,861*
ENTCOM	**3,315**	**3,67**	**2,937**
GENDER		5,186	14,647
WEALTH			(0,124)
HISCED			12,852
CULTPOS			30,401
R^2	*0,001*	*0,002*	*0,224*

Notes: Dependent variable: Science test score (PV1SCIE). Significance level: 5 percent. Put in parentheses if not significant.

4.4.2. ICT use 2.: Practical use

Practical use is more related to performance than the previous mode of use as the effects on each test scores are higher. Mathematics scores are increased for 9,7 points, reading scores for 9,07 points and science sores for 11,17 points by a frequent practical use of ICT. Whether a boy or a girl uses the computer for practical purposes does not make a remarkable difference regarding the academic performance in each field. Family background however affects this correlation even more. In the last regression model the effect of practical use on each test score decreases notably compared to the initial models. When controlling for family wealth, education of parents and cultural possessions at home the effect of practical use of ICT remains just 0,5 points for mathematic scores, 1,3 for reading scores and 2,32 for science scores.

22. Table: Computer use for practical reasons and student performance in math

	I.	II.	III.
Constant	*483,649*	*478,763*	*407,273*
PRACT	**9,709**	**9,593**	**0,508**
GENDER		10,17	19,366
WEALTH			1,401
HISCED			14,202
CULTPOS			29,706
R^2	*0,011*	*0,014*	*0,213*

Notes: Dependent variable: Mathematics test score (PV1MATH). Significance level: 5 percent. Put in parentheses if not significant.

23. Table: Computer use for practical reasons and student performance in reading

	I.	II.	III.
Constant	*495,175*	*513,479*	*450,269*
PRACT	**9,074**	**9,511**	**1,304**
GENDER		-38,1	-28,922
WEALTH			1,733
HISCED			12,46
CULTPOS			28,29
R^2	*1,733*	*1,733*	*0,234*

Notes: Dependent variable: Reading test score (PV1READ). Significance level: 5 percent. Put in parentheses if not significant.

24. Table: Computer use for practical reasons and student performance in science

	I.	II.	III.
Constant	*501,35*	*499,587*	*157,225*
PRACT	**11,173**	**11,131**	**2,324**
GENDER		3,669	13,534
WEALTH			(0,678)
HISCED			12,705
CULTPOS			29,969
R^2	*0,016*	*0,017*	*0,224*

Notes: Dependent variable: Science test score (PV1SCIE). Significance level: 5 percent. Put in parentheses if not significant.

4.4.3 ICT use 3.: Playing games

Compared to the effect of the previous modes of ICT use, the effect of a use for playing games is reverse as performance is decreased in every case by this way of ICT use. Students who frequently use ICT for playing games achieve about 6,89 less in mathematics, 18,17 less in reading and 6,92 less in science. However these effects are strongly influenced by gender. If we control for the gender of the user, playing games lowers the mathematics scores even more (-12,74 points). The same trend of change reveals for science performance. The effect of playing games on reading performance however gets moderated when adding gender as a control variable, turns from -18,17 points to -11,67 points. Family background also plays a substantial role in the relationship of playing games on the computer and school performance. For mathematic achievement the effect is almost the same to the initial model when controlling for family variables beyond gender. The net effect of the use for playing games in the last model remains -6,81 points for mathematics test scores. Reading performance is decreased also for about 6,1 points when adding all control variables in the regression. Science scores are lowered at least of all by playing games in the last model, the effect remains -4,67 points.

25. Table: Computer use for playing games and student performance in math

	I.	II.	III.
Constant	*483,649*	*472,418*	*406,126*
PLAY	**-6,892**	**-12,74**	**-6,812**
GENDER		23,379	26,017
WEALTH			2,067
HISCED			13,829
CULTPOS			29,358
R^2	*0,006*	*0,018*	*0,217*

Notes: Dependent variable: Mathematics test score (PV1MATH). Significance level: 5 percent. Put in parentheses if not significant.

26. Table: Computer use for playing games and student performance in reading

	I.	II.	III.
Constant	*495,175*	*507,65*	*449,18*
PLAY	**-18,166**	**-11,669**	**-6,101**
GENDER		-25,968	-22,9
WEALTH			2,456
HISCED			12,141
CULTPOS			28,118
R^2	*0,041*	*0,057*	*0,238*

Notes: Dependent variable: Reading test score (PV1READ). Significance level: 5 percent. Put in parentheses if not significant.

27. Table: Computer use for playing games and student performance in science

	I.	II.	III.
Constant	*501,35*	*494,224*	*165,134*
PLAY	**-6,918**	**-10,628**	**-4,665**
GENDER		14,832	18,239
WEALTH			1,426
HISCED			12,485
CULTPOS			30,058
R^2	*0,006*	*0,012*	*0,225*

5. Conclusion

The aim of our study was to investigate the relationship between ICT access, ICT use and school performance. Besides bivariate analysis we intended to reveal the net effects of ICT access and ICT use on achievement by applying multivariate analysis to control for possible influencing factors as family background and student characteristics. The analysis on the PISA 2012 data confirmed our assumption of a positive relationship: Computer and Internet availability increased test scores in mathematics, reading and science as well even after controlling for family background variables. Despite availability the use of these devices, in terms of using or not using, turned out to have a bigger impact on achievement after controlling for the students' family background. This result implicates that using ICT at home contributes to learning and a better achievement. However what to use a computer for to perform better in school? To investigate this question we analysed the effects of different types of use on school performance. The use for entertainment and communication, as browsing the internet for fun, chatting, uploading and downloading contents, etc. seems to contribute to a better achievement mostly in case of reading and science, but this effect is moderate. Therefore gender and family background do not have a strong influence on this relationship either. Practical use of a computer leads to a better performance regarding all three competencies. However the results implicate that this mode of use is strongly affected by family background as achievement points lower remarkably after controlling for wealth, education of parents and cultural possessions at home. Due to our results the third mode of use, playing games on the computer sets back performance. This effect is strongly influenced by gender and family background as well.

As our results show, ICT access and use at home do contribute to a better school performance. However the way of use also matters, as some enhance others set back academic achievement. Due to our results it seems that educational inequalities in Hungary are influenced by ICT access and ICT use. Although the students' socio-economic and cultural background has an impact on this relationship, the effect of ICT access and ICT use on performance remains more or less after filtering out the influence of these factors. We have to emphasize that our results are limited to Hungary and even if we tried to reveal the net effects by controlling for some variables, the results do not implicate a causal relationship as there might be other factors influencing both ICT access and ICT use and school performance at the same time. Further investigation should explore the effect of other or more possible influencing factors and reveal the relationship between ICT use and performance more deeply. ❋

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