COMPUTERS AT SCHOOLS: IT'S NOT ENOUGH TO HAVE THEM AND IT'S NOT ENOUGH TO USE THEM

This policy paper discusses a range of topics covering student access to computers at home and school, different uses of computers for learning and its impact on pupil outcomes. Introducing computers to schools generates both opportunities and challenges. Basic computer skills are often acquired by students without school involvement. The positive impact of computer usage at school on student performance is questionable. Governments should no longer focus solely on providing ICT equipment. The role of schools should be rather to teach students how to use computers and Internet in more sophisticated way that facilitate learning and individual development. Teaching how ICT world works, with coding classes, should be introduced to the curricula. Other key issues are to teach students how to assess reliability of Internet sources, prepare materials that motivate students, and invest in teacher skills.

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Introduction

A decade or two ago it was widely believed that computers and internet-based tools would improve education systems all over the world. Despite the lack of evidence on what works in practice, governments invested significant funds into providing schools or students with computers, software, and internet connections. Today it would be difficult to find a school in a developed country without at least basic ICT infrastructure, but the policy to provide schools with even more computers and better internet connection has lost none of its popularity. For example, in an attempt to mimic policies from other countries, the Polish government was recently discussing whether to spend major resources on providing personal laptops to all students. Although in the end the promise was not fulfilled and a much more comprehensive policy was implemented, the question remains as to whether students and schools do need more ICT infrastructure and how it really relates to teaching and learning.

In fact, it is difficult to find conclusive evidence on the positive effects of computer use on student outcomes, in core subjects or other areas. It seems that computers are helpful only when all participants know how to use them effectively for learning purposes. They can also be harmful when teachers or students lack the necessary skills or when they distract students from learning rather than facilitating it. Clearly, there are benefits but also costs for teachers and students who use ICT at schools or at home.

Recent research findings suggest that we can put too much trust in ourselves when using computers or internet. Research on multitasking demonstrates that we might actually be less effective when doing multiple tasks and that people who often do multitasking are less able to recognize important tasks. Research on internet users shows that young people often struggle with distinguishing between reliable information and sources that should not be trusted. Finally, many users of smartphones and other mobile devices show addiction symptoms, including very young kids.

Study findings are supported by anecdotal evidence, the most popular among which are stories of famous technology leaders. Steve Jobs and other inventors of new technologies were limiting the time their kids were allowed to spend with computers or on the internet. They believed new technologies were as useful as they could be harmful if used wrongly. It seems they were all too familiar with the bad sides of new technologies, while those are not always recognized by average users, especially the young ones. The downsides include high mental costs of multitasking, breach-of-privacy issues, bullying and addiction to one's favourite devices. These examples might sound familiar to those of us who have experienced anonymous attacks on the internet or are overusing smartphones in their everyday work.

On the other hand, even if evidence is unclear on the benefits of computers for non-ICT related skills, it is obvious that students need to learn how to use computers and the internet. Nowadays mastering basic ICT skills is crucial to participate in the economy and the society. However, the role of schools in this remains unclear as evidence suggests that students master computers more quickly when using it for personal purposes at home. In this note we discuss possible policies that might change this. One is to teach students on how computers really work through coding classes or by constructing simple machines. The second is

to use computers to facilitate creative work in other subjects, for example, in art or math classes.

It is important to recognize areas where computers might be useful, and understand that in some areas they might not be able to replace traditional resources. Computers and the internet might increase productivity in education just like they did in our offices. Schools already use computers to find information, create documents, connect to parents etc. Obviously, computers can increase efficiency in these standard tasks. However, when it comes to learning and teaching it seems much harder to use computers to improve quality. While sometimes the use of ICT might increase student motivation, it will not magically turn uninterested students into hard workers. To the opposite, computers might be as distractive or ineffective in some cases as they are helpful in others.

An example of a misconception about computers and learning is the belief that computers will limit the need for knowledge as all information is readily available on the internet. However, in practice students often lack the ability to find reliable sources of information and tend to trust whatever the search engine lists first. Secondly, students still need to learn core knowledge to effectively use the information they find. It is well known, for example, that our core vocabulary very often defines what we are capable to do, so it is important that students acquire as many words as possible as early as possible. Computers will never replace our vocabularies, while they can be helpful in developing them.

In this note we will try to address briefly the issues mentioned above, focusing on how policies can be transformed to facilitate students' computer use for their benefit. The note is organized as follows. In the following section we review basic evidence on the use and effect of computers on learning. In the next section we discuss different purposes of using computers in schools demonstrating the variety of possible policies in these areas. We also discuss how different groups might benefit or be harmed by computers and how policies should take that into account. Last section concludes and discusses available policy choices.

Computer use at home and at school

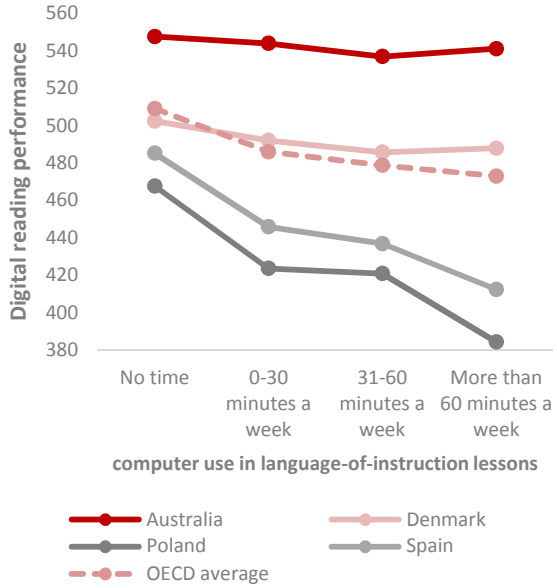
Many countries started to massively equip schools with computers already in the 90s, so by the year 2000 access to computers at school has become universal in countries like Denmark or Australia. Already in 2003 most of the OECD countries had provided more than 90% of 15-year-olds with access to computers at home or at school (see OECD, 2006, p. 22). Other developed countries followed and currently it is rather rare to find a school that makes no computers available to students, or students without portable devices with access to internet. In Europe more than 9 in 10 students are in schools with broadband access and virtually all schools have some basic connectivity to the Internet (see EC, 2013).

The fact that nearly all students have access to computers does not mean that they use it. And if they do use it, it is not necessarily for anything more demanding than browsing the internet, sending emails or printing. According to a recent ICILS 2013 study of computer skills the percentage of students at the lowest proficiency level is substantial. On average across 14 countries, 23% of students reached the basic proficiency Level 1 (see Fraillon et al., 2014, p. 98). Students at this level are able, for example, to click a link to open a webpage or paste an image to a document, but would experience problems copying a text link to a browser or editing a more complex document. Across these countries 17% of students did not even reach that level of being able to perform these sample tasks. Thus, not all students are digital natives and while they might use ICT every day they might also lack skills to benefit from it fully.

In addition, access and usage of computers vary importantly between home and school. According to the PISA 2012 survey across OECD countries almost all 15-year-olds have access to computers and use them at home for educational purposes (doing homework, checking information in the internet etc.). However, share of students who use computers at school is smaller and varies substantially across countries. In Australia, Finland or Netherlands around 90% of students report they use computers at school, while in countries such as Belgium, Ireland, Japan or Poland this share is closer to 60% and in Korea it surprisingly goes down to below 50%. Thus, the gap between usage of computers at home and at school is still substantial (see OECD, Volume V, table V.4.26).

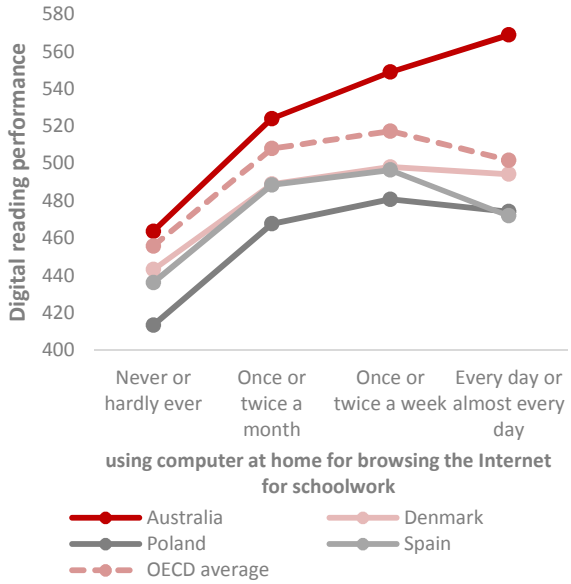
The persistence of the discrepancy could explain popular calls for policies to equip all schools and all students with laptops or tablets. While such policies could make sense for students from poorer families who still show smaller usage of ICT at home, striking evidence on the lack of correlation between the usage of computers at school and student performance makes investing into school ICT infrastructure questionable. Figure 2 demonstrates the relationship between the classroom use of computers and student performance. The data are presented for selected OECD countries and the average, and are based on the PISA 2009 study which also aimed at measuring how students read electronic texts. On average, the more classroom computer use students report, the lower the performance. This is not true for all countries: in Australia or Denmark, for example, there is almost no difference between students who use or do not use computers in their classrooms, while in Poland or Spain the relationship is negative. In any case, in none of the countries the use of computers in schools is associated with better student performance.

Figure 1. Student performance and computer use in lessons.



Source: OECD, PISA 2009 Volume VI, Table VI.6.8c.

Figure 2. Student performance and use of Internet at home.



Source: OECD, PISA 2009 Volume VI, Table VI.6.6b.

These results are even more striking when compared to the relationship between the use of computers at home and student performance. In this case, usage of computers is usually positively associated with the level of student skills. Figure 2 presents the relationship for the same countries as above and for the average. Students who use Internet at home for schoolwork outperform those who do not in all the countries. On the other hand, those who use it more often are not always showing higher achievement levels in Poland or Denmark, while in Australia the digital reading performance is strictly increasing with the frequency of using the Internet. This simple correlational evidence, also supported by more sophisticated studies (see OECD, 2012, for a review), directly relates to important policy questions. Should we invest more into school infrastructure or should we rather rely on what students are learning themselves outside the school and build on that? The crucial point here is that the answers vary depending on the purpose of computer use, to which we shall devote most of this paper.

Computers in schools: different purposes, different policies

Computers are used in schools and by students for various purposes and there is a lot of hope that in each case they will improve the quality of teaching and learning. It is important, to recognize how different these purposes are and the fact they are often independent from each other. Evidence on the effects of computers might differ in each case and we should consider different policies for different purposes while avoiding traps related to each kind of usage. While in some cases computers and the internet might have obvious benefits, in others it is dubious whether they can improve the quality of education. Below we discuss some of the most typical purposes of computer use at school.

TEACHING BASIC COMPUTER SKILLS

Usually the first and the least disputable motivation behind introducing computers to schools is to simply teach students how to use them. Mastering the use computers in office or for personal communication are the basic prerequisites for any person to function in the economy and the society. For younger people it is also often a requirement for social life. Thus, learning basic skills such as creating documents or efficiently using email is nowadays a necessary requirement for every student.

However, it is highly disputable if schools do have a crucial role to play in that. As discussed above, the evidence suggests that most of the students are learning computer skills themselves. While not all students are digital natives and some of them need to improve their computer skills, from a policy perspective it is also questionable whether it makes sense to teach all students these skills. Nowadays many students demonstrate better basic computer skills than most of their teachers and it is very costly and sometimes impossible, to improve teacher skills across the board and make sure they are up-to-date with recent developments in the ICT world.

A policy choice to be considered here is not to waste resources on a massive investment in equipment and instruction in basic computer skills as most of the student do not really need that, but rather focus on teacher training, developing digital educational content, and supporting students who lack these skills. Anyhow, it can be expected that in the nearest future fewer and fewer students will fail to learn basic computer skills by the time their teachers try to teach them. Policies should reflect that and avoid unnecessary investment.

The digital divide was the term used to describe the lack of access to computers or the Internet by some groups. In education it was used to describe a situation in which disadvantaged students lack access to computers at home while being clustered at schools with limited ICT resources. As explained above, nowadays the lack of access is rarely an issue. While even in some developed countries groups of students still have more limited access to, for example, the Internet, it is their usage of computers and the level of their skills that are worrying.

As already noted, in some cases Internet access and misuse of computers might also be detrimental to student learning. In general, students with unprivileged socio-economic background demonstrate lower computer skills and often have habits that suggest their use of computers might not always

be beneficial (see Fraillon et al., 2014). A widespread belief is that students might be even harmed by increased use of ICT, while research suggests that this might be the case especially for disadvantaged students further increasing achievement gaps (see Vigdor, Ladd, 2010).

Policies need to address these gaps as they directly translate into labour market opportunities. It should be recognized that while in some cases schools can do little to improve computer skills of students from privileged backgrounds, they might play a crucial role in forming computer skills of disadvantaged students. As students of educated parents benefit from the positive example of parents reading books since their childhood, their parents probably also care more about how they use computers or show them how to benefit from ICT at work. Such examples will be rarer in working class families and schools need to fill this gap. Otherwise, common usage of computers at work and lack of basic skills among groups of students will create another divide on the labour markets that will be very difficult to address in the adult life.

TEACHING ADVANCED COMPUTER SKILLS

A fascinating new approach to classroom computer use is to teach students how computers actually work. As already noted, students are often mastering the skills enabling them to use computers, tablets or smartphones for their own purposes at a pace with which teachers can rarely compete. However, knowledge and skills necessary to understand how computers work and how they can be programmed to creatively use their capacities are rather scarce and limited to students of advanced courses. Teachers can acquire this knowledge and transfer it to students, thus changing the rules of the game and making young cohorts masters of computers who not only use them but also know how they operate and how to use them in creative and innovative ways.

A recent example comes from UK where a new computing curriculum has been introduced. The new curriculum has been developed for kids as young as five years of age and focuses not on basic computer skills but rather on learning programming and understanding algorithms and computational thinking. The curriculum is flexible, leaving the choice of software and equipment to schools. The authors of the new curriculum emphasize that learning how to code and understanding algorithms help develop transversal skills. These skills are not strictly limited to the use of computers but improve students' ability to solve problems and think about complex tasks.

While such policies are opening a new perspective on how computers might be used in classrooms they are also rather demanding to implement. Teachers need to be capable to understand and transfer ideas and skills that are often new to them. As with teaching business in schools, it is impossible to have professionals do that as their time is too expensive, and the same is true for programmers. A key to implementing such policies is to involve teachers and provide extensive training for them before asking them to teach new skills.

TEACHING WITH COMPUTERS

Another common cause for massive investment in ICT infrastructure is the belief that computers will improve teaching and learning. This is where most of the controversies arise. Businesses support technological solutions in schools as they present them with endless market opportunities. Governments often support ICT investment as it is easy to implement and highly visible policy although it might be very costly. These investments are usually based on a strong belief that computers will improve the quality of teaching and learning as they improved efficiency almost everywhere else. However,

they are rarely based on evidence what in fact works when it comes to using computers in the classrooms. The evidence we already have suggests that the benefits of using computers for learning in schools are small if not negligible, and it is hard to find areas where using computers clearly outperforms more traditional ways of teaching (for a review of research evidence see OECD, 2012).

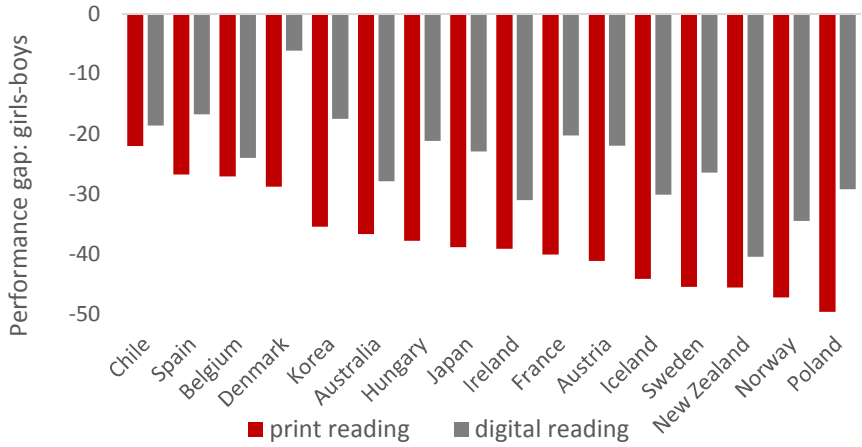
However, more promising approaches have been developed. They do not try to improve traditional ways of teaching and learning but use computers to introduce new methods that would not be possible otherwise. For example, the newest developments in the area of electronic textbooks are not simply providing the same content in an electronic and maybe more attractive form. They are interlinked with assessments and tools to monitor workload and student progress. They check, for example, if students mastered enough material to proceed further and provide instant feedback to students, supporting their self-studying efforts and providing helpful insights to instructors. Other approaches use interactive computer games to develop skills and master knowledge in a more fun, but also more efficient way. These approaches are novel and cannot be applied without computers. As they are still in the developmental phase it is not possible now to compare their effectiveness to more traditional approaches.

Using computers for learning requires substantial resources. Even if equipment costs are decreasing, innovative approaches require substantial investments in content development, programming and training. Instructors who use computers or the internet for teaching know perfectly that preparing classes, effectively communicating with students and controlling their efforts requires substantially more work than with traditional methods. Thus, a good policy strategy would be to consider investment where computers add value to teaching and learning rather than replace traditional methods with more expensive and sometimes less effective ICT tools. It is also important to plan policy from the educational perspective before considering requirements of the technology. In other words, those who have expertise in teaching should have priority in planning before those who will equip schools with necessary infrastructure.

One of the most important findings from international studies is that the so-called reading gap exists in all countries. PIRLS results show that boys are outperformed by girls in reading at the age of 10, which is often explained by different developmental paths, but the gap still remains substantial at the age of 15. PISA data show that at this age the reading gender gap is close or above the equivalent of one year of schooling. The gap is related to how much boys read and what they read (see PISA 2009, Volume III). Girls read and enjoy reading more than boys, and usually read more complex texts like books or magazines, while boys prefer comics and other shorter texts. The gap is much larger for disadvantaged students with far too many boys from unprivileged backgrounds not able to understand even simple texts.

As depicted on Figure 3, in most countries the gender reading gap becomes much smaller when the test is conducted on computers and when reading of Internet-like information is assessed. In Poland, the gender gap in print reading is the largest, but it diminishes by around 20 score points in digital reading ($1/5^{th}$ of the standard deviation on the PISA scale). Similarly in Austria, Denmark, France or Sweden. However, while in Denmark the gap in digital reading is almost negligible, it remains substantial in Poland. Creating environments where boys are motivated to read and use computers in a way that provokes them to read longer texts might be a way to improve their skills. That possibility is still widely unrecognized, primarily because in many countries educational policies fail to target

Figure 3. Gender gap in print and digital reading.



Source: Own calculations based on the PISA 2009 dataset.

gender separately, focusing instead on uniform solutions that cannot exploit this opportunity. On the other hand, in countries like Chile or New Zealand there is little difference between the print and digital reading, but in Chile the gender gap is around half of what is found in New Zealand. Thus, even when it comes to gender differences countries face different challenges and various policy opportunities.

While boys too often lack basic reading skills, girls too often doubt their skills in mathematics and science or are not motivated enough (or even demotivated) to excel in this area. At the same time girls are less often big fans of computers or the Internet and sometimes show similar anxiety with computers as they do with mathematics or science. A policy challenge in this case is to change this gender imbalance by, for example, fighting common stereotypes that boys do math and computers while girls do humanities, or to promoting the development of computer and Internet tools that are more female friendly. Some examples of such policies come from countries as different as Korea, Poland and Turkey, but clearly there is much more to be done in this area.

A range of distinct educational possibilities arises when computers are connected to the Internet. Students are nowadays extensively using the Internet to find facts and data. Sometimes they also use it to take extra courses. This is the area where much hope and money was placed but currently it is widely recognized that the approaches developed are not working as expected. Distant learning through Internet targets student groups that are geographically spread. The Internet can be also used for social purposes related to schools and for effectively communicating with parents. Finally, connecting schools and students means that modern assessment tools can be applied not only to provide instant feedback to teachers, parents and students, but also to monitor the system by using big data approaches.

Although Internet use and its benefits vary between educational and training programs, some critical issues are best highlighted in the short but fascinating history of MOOCs. Massive open online courses were launched very recently, creating a widespread belief that the highest quality education will be soon accessible to students all over the world. Leading American universities established their websites or joined partnerships to develop Internet-based educational content and attract new students. While the idea was extremely popular in the beginning it quickly demonstrated that many hopes cannot be fulfilled. Up to now MOOCs are mostly taken by students of traditional universities as an

addition to their normal studies. Moreover, dropout rate is substantial and few students engage in online discussions or exercises. On the other hand, MOOCs still provide an option for students and those who do not wish to enrol to university to expand their knowledge. In any case, it is clear now that MOOCs will not replace traditional education yet, but they might provide a useful addition to it.

Fast growing Internet resources also question the need to learn facts. A popular claim is that nowadays students should not focus on knowledge but should primarily develop their skills in finding and analysing information on the Internet. In fact, recent curriculum reforms in many countries have emphasized learning skills rather than acquiring knowledge. However, experts and teachers alike are aware that basic knowledge is always necessary to apply skills, and the distinction between skills and knowledge is often misleading. Young kids, for example, are not able to read longer texts if they do not possess sufficient vocabulary. University graduates are able to read scientific articles as they possess necessary knowledge which they did not have when starting their studies. Thus, while the Internet allows us to remember less, we still need to learn basic vocabulary in any discipline to use our skills effectively. What is also important nowadays is to teach students how to assess the quality of information available in Internet and distinguish reliable sources of information from what populates the Internet.

COMPUTER-BASED ASSESSMENT

An intensive area of recent developments is computer-based student assessment and monitoring of the school system. A common belief is that computer-based assessments are cheaper and easier to implement and use. It is rarely the case, however, that moving from paper and pencil tests to computer based assessments lowers the costs. As examples from many countries suggest it might actually be the opposite. It is also not true that computer-based assessments are better in measuring student skills. Adaptive tests developed on computers bring all kinds of technical problems and are rarely more efficient in limiting measurement errors. Finally, the most expensive component of any modern assessment is marking. This cost cannot be avoided unless one wants to rely on the simplest ways to assess students, like multiple choice questions. Human markers are needed to assess more complex tasks and using computers in this regard is not very helpful. When one adds the increased costs of security, equipment and training the benefits of computer-based assessments are not that large. We are still waiting for a new wave of computer based tests that will measure skills that cannot be measured with paper and pencil tests (like the way in which a student attempts to solve a problem). However, it should be borne in mind that developing such tests is very resource-consuming and still not based on substantive research.

COMMUNICATION AND PARENTAL INVOLVEMENT

In schools, the area which is probably most visible to a wider audience is the way schools communicate with parents and try to monitor student work at home. Many schools are now registering student data on computers that are often connected to the Internet and can be accessed by parents. This way parents can continuously monitor efforts of their kids but also communicate with teachers. Some schools also use homework assignments that are computer-based and monitor how student work outside school.

Clearly, constant monitoring of student work changes the dynamic between students, parents and teachers. It might support better involvement of parents and motivate students to work, but it also sometimes creates a much more stressful environment. The solutions that

are applied should be discussed locally between parents and schools and it is difficult to imagine a state wide policy that implements such solutions successfully. On the other hand, in many countries this area still needs to be regulated to preserve the basic rights to privacy.

A common complain among teachers nowadays is that parents show less and less involvement in education and that they come to schools as customers instead of viewing education as the common effort of the school and the family. While this is less a of a problem in Asian countries, in Europe, for example, schools struggle with involving parents into their work. The Internet might help in this regard by providing the tools for continuous communication between parents and teachers. As already discussed above, there are some controversies on using internet-based solutions to monitor students and communicate with parents on a constant basis, however, it is also clear that the Internet can be used to better involve parents into school work.

THE DANGERS OF CLASSROOM COMPUTER USE

Computers are not always used in a way that stimulates any kind of learning and they can have a detrimental impact on our mental capabilities. Many people are using smartphones just for communication or socializing with no effort to learn and explore more advanced possibilities. People also often find their attention disturbed by the media, with recent research showing that this might have important negative consequences. Research on multitasking demonstrated relatively long time ago that there are non-negligible switching costs that do not evaporate even if we know we have to prepare for switching (Rogers, Monsell, 1995). Apparently, this strand of research translated into polices that affect almost everyone nowadays, like the restriction of mobile phone use while driving.

A recent strand of research demonstrates that when it comes to modern media people cannot perform several tasks even if they believe they can. Moreover, research evidence suggests that people who are "heavy media multitaskers" are suffering from being distracted by irrelevant information much more than those who are "light media multitaskers". As a consequence, people who are confident that they can manage multiple sources of information are performing worse on multitask tests as they seem to be less able to focus on important pieces of information (Ophir, Nass, Wagner, 2009).

This strand of research is of relevance to all of us working in an environment full of distracting sources of information, but it might be even more important for today's students who are often raised in a world where talking to your friend while reading several pages on your mobile and checking social networks on your laptop is something natural. One does not need research studies to see that this is happening: it is enough to visit a nearby café to see how teenagers socialize with their smartphones always turned on and taking as much of their attention as friends sitting next to them. Another striking example is the change in the attitude towards using mobile devices during classes by on the experts who supported new media since the beginning. Professor Clay Shirky from the New York University, in an open letter published in the internet, explains why he changed his view on the use of Internet and mobile devices during his classes: "Over the years, I've noticed that when I do have a specific reason to ask everyone to set aside their devices (…), it's as if someone has let fresh air into the room. The conversation brightens, and more recently, there is a sense of relief from many of the students. Multi-tasking is cognitively exhausting; when we do it by choice, being asked to stop can come as a welcome change." (Shirky, 2014).

The use of ICT can in the extreme cases even be regarded an addiction. As today being connected is for some people the question of

"to be or not be", students are often caught in a situation where they cannot disconnect and have to constantly check social networks and messages or chat with friends. The costs of such extreme multitasking are probably very high but in this case psychological costs of addiction are probably even more severe. Similar problems are related to games addiction. These are relatively new issues that are rarely recognized by teachers who are not yet aware of them or are not training in dealing with them.

A better recognized issue is bullying or stalking using the Internet. That is one of the reasons technology leaders like Steve Jobs were limiting their kids' access to social media. Examples of extreme situations where teenagers commit suicides because of private pictures published on the web or hateful comments spreading in the internet are highly publicized in all countries. While the issue is recognized it is very difficult to fight. Parents and teachers alike have the same problem of accessing information that is privately shared by teenagers to limit dangers of wrong usage. A possible policy is to train teachers and parents how to respond to such situations and how to recognize the dangers. In many countries law is not yet ready for such situations and it seems more important to create awareness of these issues rather than to limit the usage of internet.

A final issue that is generally related to the use of computers and the Internet is privacy. Electronic data are never fully secure and most of the users expose themselves to potential treats by not using secure connections or by publishing information that might be used against them. These issues are complex and only few countries have developed their legal frameworks to protect young kids and teenagers in line with the recent developments in ICT. Difficult questions arise when discussing the extent to which parents should be able to monitor information exchanged by their kids, or the dangers of posting information by teenagers that might be potentially used against them. As modern ICT improved communication providing endless means to exchange information, it has also created the dangers of using this information in a way that was not intended by those who published it.

MONITORING SYSTEMS WITH THE HELP OF ICT

Finally, by extensively using computers in schools it is possible to collect data to monitor the system, improve resource allocation or evaluate policies. In countries where such data are not only collected but are made accessible to the government and/or to the researchers, useful analyses are often conducted. The so-called big data approaches have been applied recently to educational data, especially with the massive amount of information that comes from computer-based assessment systems. These systems are not only providing scores for each student but also monitor the way they approach questions or work with a computer.

While the availability of such data can potentially benefit educators or policy makers, it is also true that in many cases this information is not explored. A good example are countries that participate in international studies like PISA, PIRLS and TIMSS. Only few countries conduct extensive research projects exploring the vast amount of information available. For the majority of countries the international reports provided by the institutions conducting these studies (OECD and IEA) remain the sole analytical attempts to use the collected information. The majority of countries do not benefit from the richness of these data. Similarly, many countries collect information from schools using computer systems but analytical attempts are usually even less frequent in this case. This is because it is not enough to build infrastructure and collect the data. Much more difficult is to build analytical teams that are able to answer policy questions.

Policy conclusions

We discussed a broad range of topics covering student access to computers at home and school, different uses of computers for learning and the impact of ICT use on different groups of students. One point of this discussion was to demonstrate the complexity of the issues related to classroom computer use. Anyhow, some clear policy messages arise when summing up this evidence:

a) Basic computer skills are often acquired by students without any school involvement. Nearly all students use computers or devices connected to the Internet and they usually master basic skills faster than teachers or parents. Policies should focus on those who lack behind but in general there is no need to equip students and families with computers or Internet access.

b) The role of schools is to teach students how to use computers and Internet in more sophisticated ways that facilitate learning and individual development. Policies aiming at teaching how computers work and how to master them to address own needs should be central to modern teaching. Policies should recognize that some students will need special help in this regard as they lack motivation to develop a deeper understanding of ICT.

c) Governments should no longer focus solely on providing equipment. The key is to train teachers, prepare materials that motivate students and expand their use of computers, but also to support those who lag behind in modern technologies.

d) Using computers and Internet brings some risks that should be recognized and openly addressed by policies. Students need to learn how to differentiate between reliable and useless information. They should also be able to recognize dangers and misuse of Internet access. Teachers need to help students to use computers responsibly and safely.

References

EC (2013). *Survey of schools: ICT in Education.* European Commission.

Fraillon, J., Ainley, J., Schulz, W., Friedman, T., Gebhardt, E. (2014). *Preparing for life in a digital age: The IEA International Computer and Information Literacy Study international report*. Cham: Springer.

OECD (2006). *Are Students Ready for a Technology-Rich World?: What PISA Studies Tell Us.* OECD Publications, Paris.

OECD (2012). *Connected Minds: Technology and Today's Learners, Educational Research and Innovation*, OECD Publishing.

Ophir E., Nass C., Wagner A.D. (2009). *Cognitive control in media multitaskers.* PNAS 2009 106 (37) 15583-15587

Rogers R., Monsell S. (1995). *The costs of a predictable switch between simple cognitive tasks. Journal of Experimental Psychology: General*, 124*,* 207-231.

Shirky C. (2014). *Why I Just Asked My Students To Put Their Laptops Away*. Accessed at https://medium.com/@cshirky/why-i-just-asked-my-students-to-put-their-laptops-away-7f5f7c50f368

Vigdor J.L., Ladd H.F. (2010). *Scaling the Digital Divide: Home Computer Technology and Student Achievement,* National Bureau of Economic Research, NBER Working Paper 16078.

WWW.IBS.ORG.PL