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ICT AND STUDENTS' SKILLS[1]

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The article presents the results of a survey of schools on ICT in Education, conducted by the European Commission in 2011, the primary goal of which is to benchmark countries' performance in terms of access, use and attitudes to ICT. The respective comments on these results are also forwarded. The survey findings underline the importance of developing ICT use during lessons in school for students to become more confident in their digital competence. Increasing the amount of well-designed ICT-based activities in school is the best way to increase the number of digitally confident and supportive students, their skills, ability, as well as ICT achievements. The paper attempts to develop the understanding as to why the situation is as reported through the Survey. Based on a review of previous studies and empirical fieldwork, the paper demonstrates that sustained educational transformation using ICT involves more than pedagogical awareness alone, and that a broader array of factors should also be taken into consideration.

1. Introduction

Education is one of the main keys to economic development and to improvement in human welfare. As global economic competition grows sharper, education becomes an important source of competitive advantage, closely linked to economic growth, and a way for countries to attract jobs and investment one of the key determinants of the value of lifetime earnings. Countries therefore frequently see raising educational levels and broadening access as a way of tackling poverty and deprivation. Computers are spreading rapidly in schools not just in wealthy countries, but increasingly in the developing ones as well. However, although schools have had computers in classrooms for almost two decades, ways to use them effectively have evolved slowly and patchily. Schools use ICTs in two main ways: for administration and routine tasks of classroom management, and for instruction. In the classroom, they have two main instructional roles: for teaching ICT skills and as a tool for teaching other subjects.

[1] This paper is an extended version of the original presentation, made at the BOS 2014 (Operations and Systems Research) conference in Warsaw in September 2014.

Evaluating technology projects is notoriously difficult. Even more so is the evaluation of educational interventions. School influence on pupils' academic or social outcomes explains only about 12 to 15 per cent of the variance, leaving 85 per cent or more to be explained by the influence of factors such as the child's family background, lifetime experience, natural ability and so forth (Cairncross, 2003). Many early experiments with ICTs in classrooms were based on nothing more than enthusiasm or hunch. However, the growing emphasis on the need to show concrete benefits has led to more attempts to evaluate the impact of computers in classrooms. But evaluating ICTs in education is particularly hard, for a number of reasons (Cairncross, 2003).

In terms of their use of ICTs as a teaching tool, schools fall into three broad categories. Many conventional schools in rich countries use computers in the ways that schools usually take with the conventional teaching tools, or in order to improve the efficiency of communication with students and administration. For developing countries, one of the most important uses of ICTs in schools may be the one that simply also applies in schools: as an inexpensive way to gain access to teaching materials, which are expensive to create. In rich countries, ICTs are now widely used in schools classrooms (Cairncross, 2003). In the United States in particular, schools students frequently have access to computers in class. Sometimes, the school provides personal computers (PC), but increasingly, the installation of wireless loops allows students to use their own laptops for access to the Internet anywhere in the school buildings, including in class. Although these are widely used for teaching scientific subjects, anecdotal evidence suggests that they are less useful for teaching other courses. Instead, lecturers are growing used to the idea that they have to compete with the Internet and e-mail for their class's attention.

2. ICT in the school education system of Poland

In Poland (EC.EUROPA, 2014), the educational system is centrally managed by the Ministry of National Education and the Ministry of Science and Higher Education. Full-time compulsory education in school covers children and young people aged 6-16 years, whereas part-time compulsory education (to be received in school or non-school settings) concerns young people aged 16-18 years. Upper secondary schools, which are not compulsory, are attended by the vast majority of the population in the age group 16-19/20 years and are administered by district authorities. Only the national educational policy is developed and implemented centrally, while the management of education and the administration of schools is decentralized. The responsibility for the administration of primary schools and lower secondary schools is delegated to the communes, with management of schools above the lower-secondary level, art schools and special schools has been delegated to districts as their statutory responsibility. The responsibility for pedagogical supervision rests with the heads of the regional education authorities in 16 provinces.

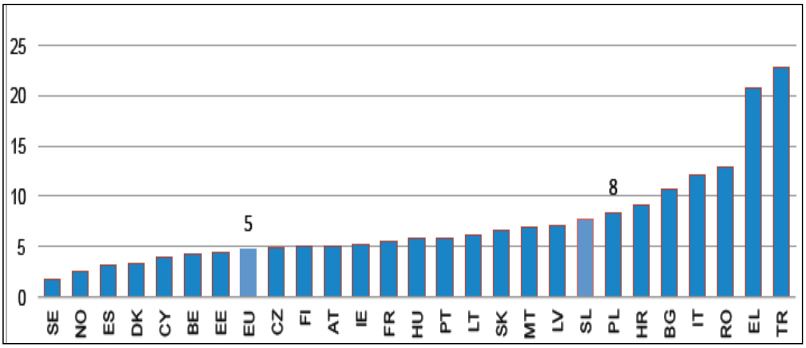
According to Eurydice's Key Data on Learning and Innovation through ICT at school in Europe (EC.EUROPA, 2014), in Poland there exist national strategies covering training measures in all areas except for the area of ICT in schools. There are central steering documents for all ICT learning objectives at secondary education level and for knowledge of computer hardware and electronics, using a computer, using mobile devices, and searching for information, at primary level. In primary and secondary schools ICT is taught as a general tool for other subjects/or as a tool for specific tasks in other subjects, and also taught as a separate subject, and in addition in secondary schools ICT is included within technology as a subject. At primary and secondary education level recommendations or suggestions and support are provided in all ICT hardware areas, and for all ICT software categories. According to official steering documents, students and teachers at secondary level are not expected to use ICT in subjects either in class or for complementary activities. There are no central recommendations on the use of ICT in student assessment. Public-private partnerships for promoting the use of ICT are encouraged for providing extra-curricular activities (EC.EUROPA, 2014).

3. The Use of ICT in Education: a survey of schools in Europe

In 2011, the European Commission Directorate General Communications Networks, Content and Technology (European Schoolnet, 2012) launched the Survey of Schools: ICT in Education, the primary goal of which was to benchmark countries' performance in terms of access, use and attitudes to ICT at grades 4, 8 and 11. The Survey of Schools is one of a series within the European Union's cross-sector benchmarking activities comparing national progress to Digital Agenda for Europe (DAE) and EU2020 goals. The Survey is funded by the European Commission Communications Networks, Content and Technology Directorate General and is a partnership between European Schoolnet and the Service d'Approches Quantitatives des faits éducatifs in the Department of Education of the University of Liège. The survey took place between January 2011 and May 2012, with data collection in autumn 2011, and covered 31 countries (the EU27, Croatia, Iceland, Norway and Turkey). In four countries (Germany, Iceland, The Netherlands, and the United Kingdom) the response rate was insufficient, making reliable analysis of the data impossible; therefore the findings in this report are based on data from 27 countries.

A computer is defined as a desktop or laptop, notebook or tablet computer, whether or not connected to the internet, available for educational purposes in school. In Poland there are fewer computers available for all grade students than in the EU on average and provision is fairly consistent at all grades, although it is close to the EU average at grade 4. In most countries the older the student the more the computers, although it is less than half of this trend that is reflected in Poland at grade 11 vocational. Fig. 1 shows that at grade 8 Poland ranks in the lower group of countries on this indicator with 8 students per computer. At other grades the position is similar.

Fig. 1. Students per computer (grade 8, country and EU level, 2011-12)

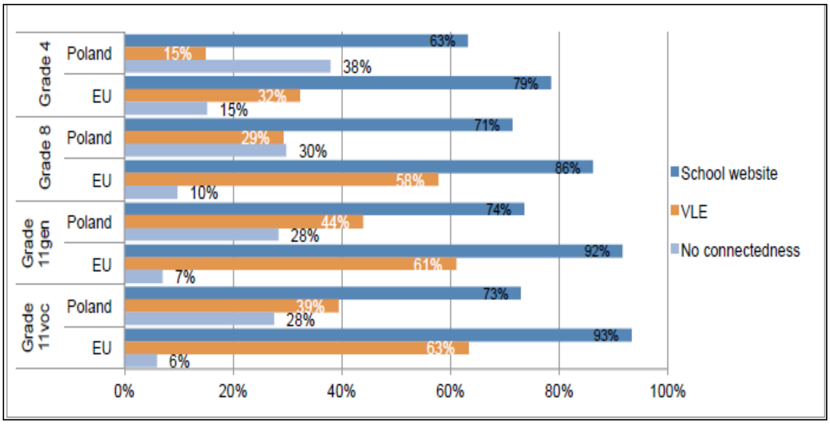


Source: European Schoolnet (2012)

At grade 8 there are on average in the EU five students per computer, only Sweden, Norway, Spain, Denmark, Cyprus, Belgium, Estonia having lower numbers of students per computer, and six countries Croatia, Bulgaria, Italy, Romania, Greece, Turkey having more students per computer than Poland.

Percentages of students in schools that have 'connected' characteristics, e.g. having a website or a virtual learning environment (VLE) are shown below, as well as those with none of these items (Fig.2). In Poland, a lower percentage of students than the EU mean are in schools with a website, and also fewer in schools with a virtual learning environment at all grades. Percentages of 'unconnected' schools are consistently higher that the EU average.

Fig. 2. Percentage of students schools – website, virtual learning environment, no connectedness (Poland and EU, 2011-12)

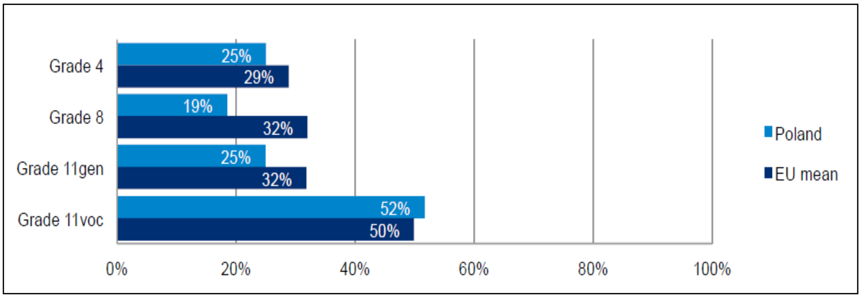


Source: European Schoolnet (2012)

Almost three-quarters of grade 4 students are in schools with a website or VLE. There are students in all countries in schools with none of these features (15% on average in the EU), most in Poland (38%). On average in the EU, 86% of grade 8s are in a school with a website, while in Poland – 71%, on average in the EU 58% are in schools having VLE, while in Poland – only 29%. Poland has 30% grade 8 students in schools with no 'connectedness', followed by Romania (32%). The lowest numbers of students at such schools are in Slovenia and Finland (both 1%). At grade 11, the highest share of students in schools with no 'connectedness' was found in Poland (28%) and the lowest in Estonia.

Teachers' frequency of use of ICT during lessons is shown in the chart of Fig.3. In Poland, the ICT frequency of use by teachers is close to the EU average. The number of teachers using ICT in more than 25% of lessons is close to the EU average. The most intense use of ICT is found at grade 11 vocational, where over a quarter of teachers use it in more than 75% of lessons.

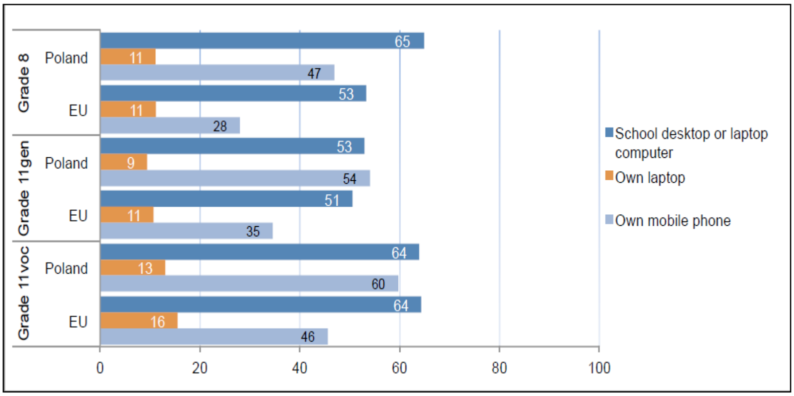
Fig.3. Teachers' use of ICT in more than 25% of lessons
(% students, Poland and EU, 2011-12)



Source: European Schoolnet (2012)

Students at grade 8 and 11 were also asked in the study here commented upon how frequently they used various items of ICT equipment in their lessons for learning purposes (Fig. 4). The chart in the figure shows their reported intensity of use of a school computer, and their own laptop, or mobile phone. In Poland, student use of computers in class is close to the EU mean, while their use of their own laptop is in line with the EU mean. However, mobile phone usage is above the EU mean at all grades.

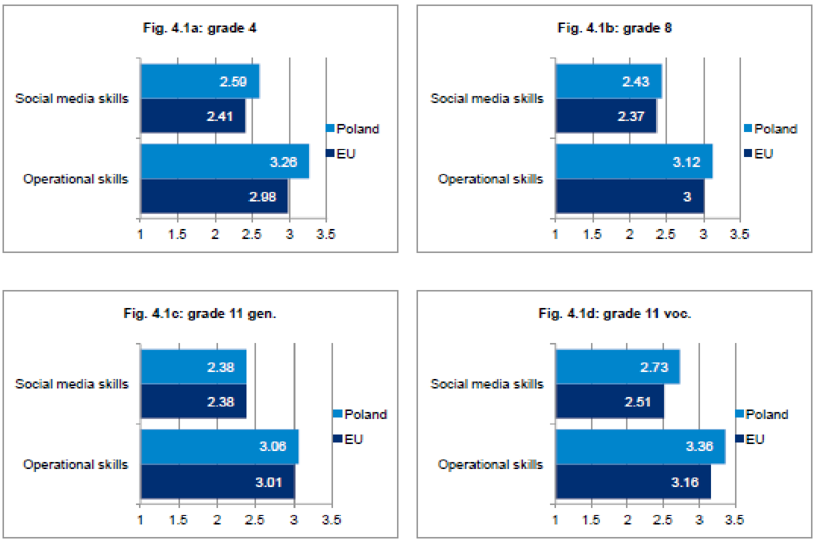
Fig. 4. Percentages of students using ICT equipment in class for learning, at least once a week (Poland and EU, 2011-12)



Source: European Schoolnet (2012)

In Poland, teachers' confidence in their operational skills with ICT is higher than the EU mean (close to 'somewhat') at all grades (Fig. 4.1). Their confidence in social media skills is generally above the EU mean (between 'a little' and 'somewhat').

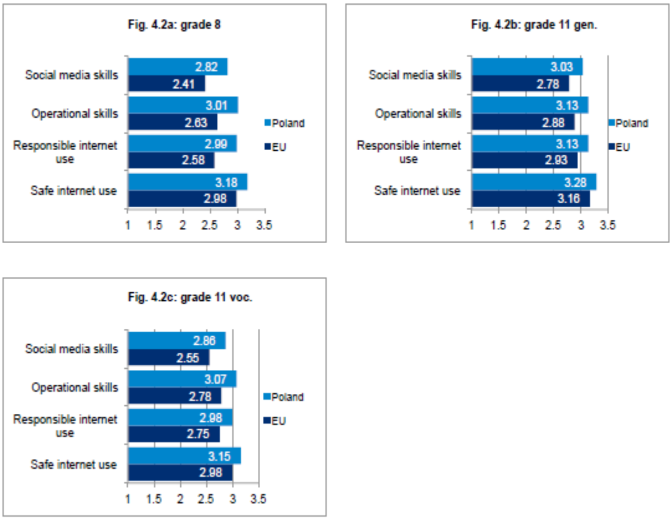
Fig. 4.1. Teachers' self-confidence in their operational and social media skills (by grade; mean score of students with 1 being 'none' and 4 being 'a lot'; Poland and EU; 2011-12)



Source: European Schoolnet (2012)

In Poland, students' confidence in their social media and operational ICT skills is above the EU mean at all grades (Fig. 4.2).

Fig. 4.2. Students' self-confidence in their ICT skills (by grade; mean score of students with 1 being 'none' and 4 being 'a lot'; Poland and EU; 2011-12)



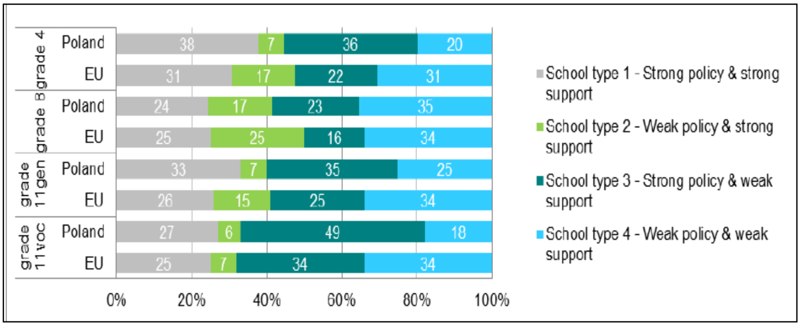
Source: European Schoolnet (2012)

Figures 4.1 and 4.2 illustrate the fact that the mean scores of students across grades, taught by the teachers who are confident in using social media, are substantially lower than for those taught by the teachers confident in operational ICT (both regarding the EU average and Poland). The mean scores of students at grade 11 (vocational education) taught by the teachers expressing confidence in their operational ICT skills as well as in using social media skills are higher compared to the confidence rating in these areas at any other grade in general education. We observe that the mean score of students taught by the teachers declaring confidence in their operational use of ICT increases slightly with students' age. The mean score of students taught by teachers confident in social media, however, decreases at grade 4, and further at grades 8 and 11 (of general education).

4. Digitally supportive school, teacher and student

Results from the Survey of Schools: ICT and Education suggest that a 'digitally supportive school' develops strong concrete support measures for teachers to use ICT in teaching and learning (ICT coordinator, teacher training, etc.), whether or not associated with strong policies (written statement about introducing ICT in teaching and learning and/or in subject, etc.). In Poland, percentages of students in schools with strong support are around EU means, slightly above at grades 4 and 11 general (Fig. 5).

Fig. 5. Percentages of students by school type in terms of policy and support (all grades, Poland and EU, 2011-12)



Source: European Schoolnet (2012)

The concept of the 'digitally supportive teacher' also emerged from a close analysis of the data. Such teachers have high confidence in and a positive attitude towards ICT and high access to ICT and low obstacles to using it. Teachers having high confidence in and a positive attitude towards ICT even seem to be able to overcome low access to ICT and high obstacles. Percentages of students taught by digitally supportive teachers in Poland are above EU means, except at grade 11 general (Figs. 6.1 and 6.2).

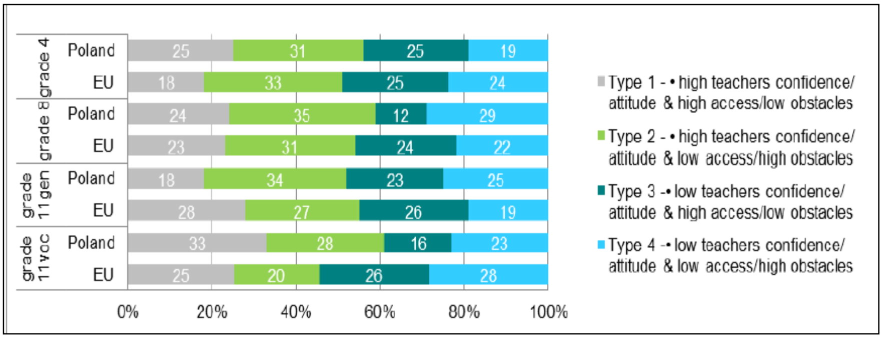
A digitally equipped school is well equipped in general ICT terms, has fast broadband (above 10mbps) and is 'connected' (i.e. has at least one of these: a website, email for teachers and students, a local area network, a virtual learning environment). Analysis of the data revealed three clusters of schools according to these measures:

Type 1: Highly digitally equipped schools, characterized by relatively high equipment levels, fast broadband and relatively high connectedness;

Type 2: Partially digitally equipped schools, with lower than type 1 equipment levels, slow (less than 10mbps) or no broadband, and some connectedness;

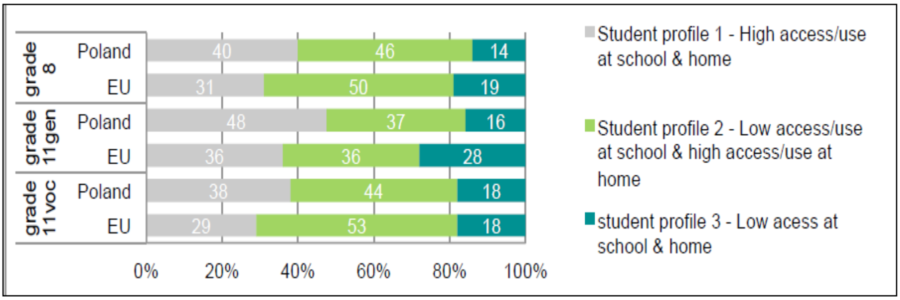
Type 3: As type 2 but with no connectedness.

Fig. 6.1 Percentages of students by type of T&L conditions[2]
(teachers' confidence/attitude &access/obstacles) (all grades, Poland and EU, 2011-12)



Source: European Schoolnet (2012)

Fig. 6.2. Percentages of students by profile in terms of ICT use at home and at school (all grades, Poland and EU, 2011-12)



Source: European Schoolnet (2012)

In Poland, percentages of students in type 1 schools are lower than in other countries, considerably so at grades 4 and 8 (Fig. 7).

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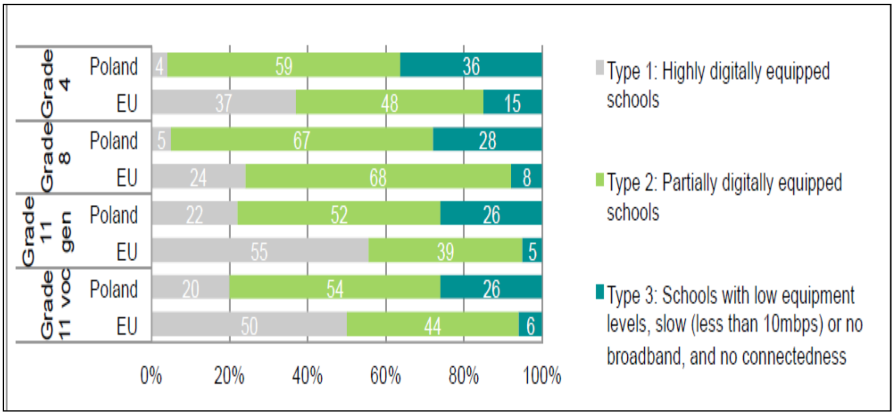
[2] *Transform, clipping, and lighting* (T&L or sometimes TCL) is a term used in computer graphics – one of the basic functionalities, especially regarding computer games, implemented in hardware form.

Fig. 7. Digitally equipped schools (in % of students, Poland and EU, 2011-12)



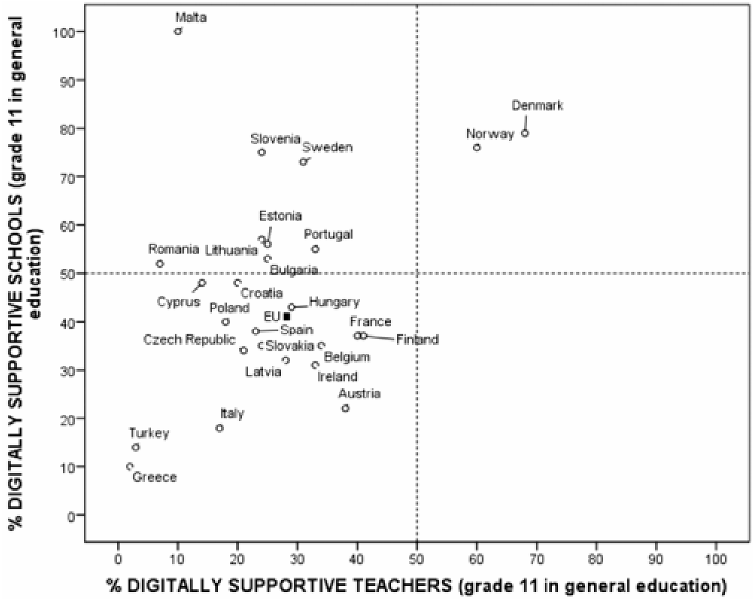
Source: European Schoolnet (2012)

This article presents the main findings of the exploratory part of the analysis commented upon, introducing the concepts of digitally supportive school, digitally confident and supportive teacher and digitally confident and supportive student, estimating their respective proportion at EU level on average and by country and investigating whether high percentage of digitally supportive schools include high percentages of digitally confident and positive teachers and students. A few recommendations for policy making at European, national, regional/local and institutional levels conclude the article.

Digitally Confident and Supportive Teachers and Digitally Supportive Schools

To some extent (the correlation coefficient being equal 0.33), as the percentage of digitally supportive schools increases, so does that of digitally confident and supportive teachers. While there may be national or regional contexts that favor the development of digitally supportive schools and digitally confident and supportive teachers, the data do not allow us to affirm whether digitally supportive schools encourage teachers to become supportive or the reverse. A coefficient correlation does not, of course, prove a causal relationship, but simply confirms the numerical association between phenomena. In other words, where we find digitally supportive schools, we also find digitally confident and supportive teachers (Fig. 8).

Fig. 8. Digitally supportive schools and digitally confident and supportive teachers



Source: Wastiau (2013)

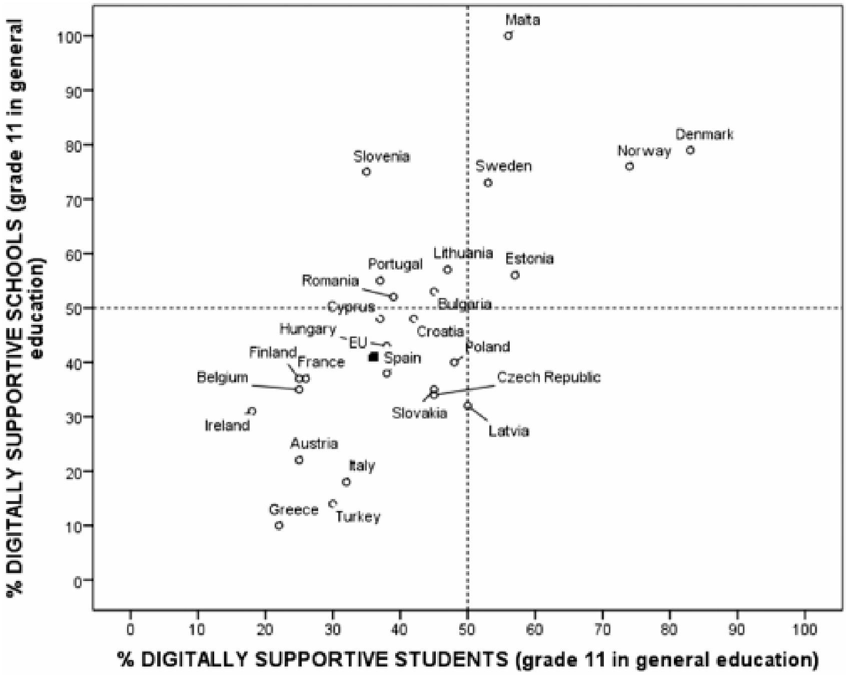
Mapping of countries according to their respective percentages of students in digitally supportive schools and the percentages of students taught by digitally confident and supportive teachers is presented in Fig. 8. It shows that at grade 11 in general education, the percentages of students taught by digitally confident and supportive teachers are especially high in Denmark and Norway compared to all the other countries; Poland is near average EU, Croatia, Spain and Czech Republic.

Digitally Confident and Supportive Students and Digitally Supportive Schools

Mapping of countries by percentages of students in digitally supportive schools and percentages of digitally confident and supportive students is presented in Fig. 9. To quite a high degree (correlation coefficient of 0.70), countries with a high percentage of digitally supportive schools also have a high percentage of digitally confident and supportive students; conversely relatively few digitally confident and supportive students can be found in countries with few digitally supportive schools.

Across the EU countries, on average 30–35% of students are digitally confident and supportive students. The highest percentage of such students is observed in grade 11 of general education, namely 36%. Yet there are important variations between countries. The highest percentage is found in Denmark at all grades, whereas Austria, Belgium, Finland and Ireland are amongst the lower five countries for both grade 8 and grade 11 (general education).

Fig. 9. Digitally supportive schools and digitally confident and supportive students



Source: Wastiau (2013)

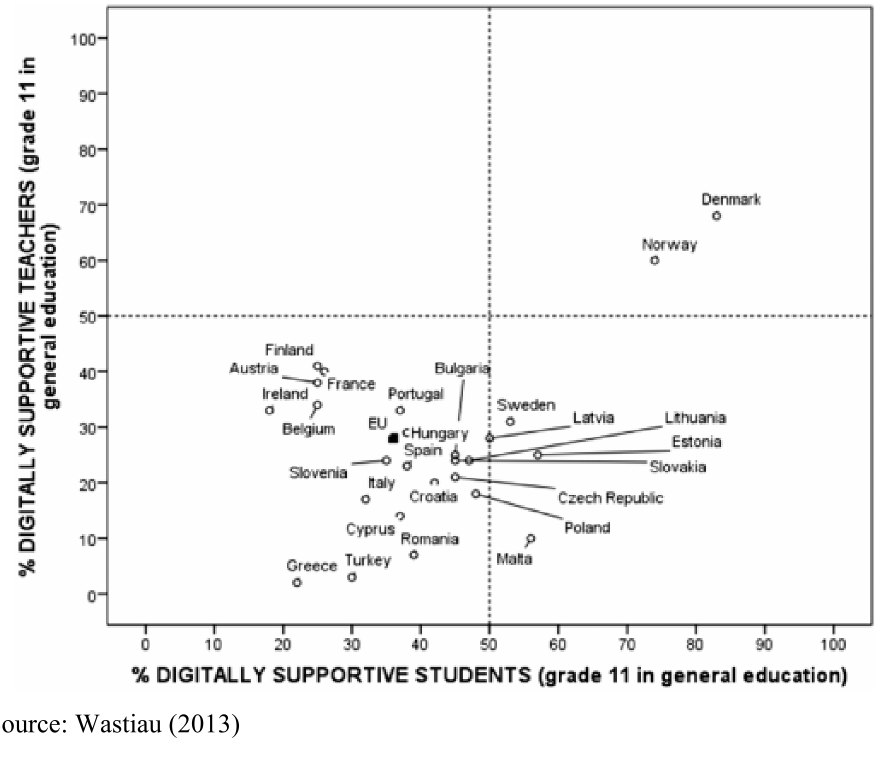
In Poland, the percentage of students in digitally supportive schools is at around 50%. The results from the survey also demonstrate that educational systems with a high percentage of digitally supportive schools include a large percentage of digitally confident and supportive students. So, it can be inferred that digitally supportive schools can help foster digitally confident and supportive students.

Digitally Confident and Supportive Students and Teachers

Finally, a relation is also observed between digitally confident and supportive teachers and digitally confident and supportive students. To some extent (correlation coefficient of 0.43), countries with a high percentage of digitally confident and supportive teachers are also countries with a high percentage of digitally confident and supportive students (even if the correlation is not statistically significant which, as mentioned previously, is not surprising because of the size of the population concerned here, is the number of participating countries).

Mapping of countries according to percentages of students taught by digitally confident and supportive teachers and percentages of digitally confident and supportive students is presented in Fig. 10. It shows that, in most cases and in all countries, percentages of students taught by digitally confident and supportive teachers are below 50%. At grade 11 in general education, percentages of digitally confident and supportive students are nevertheless above 50% in Estonia, Malta, Sweden, and especially in Denmark and Norway; only in these two last countries, percentages of students taught by digitally confident and supportive teachers are also high above 50%; Poland is above average EU, Slovakia and Czech Republic.

Fig. 10. Digitally confident and supportive teachers and students



Source: Wastiau (2013)

Correlation analysis reveals relationships between three profiles that the descriptions provide, for each country, expressed through the percentages of (i) digitally supportive schools, (ii) digitally confident and supportive teachers, and (iii) digitally confident and supportive students. Education systems characterized by a high percentage of digitally supportive schools include a large percentage of digitally confident and supportive teachers or students, and vice versa. More than 70% of teachers surveyed at all grades expressed a positive or very positive opinion about the relevance and positive impact of ICT to support different students' learning processes (working collectively, autonomously, practicing, etc.) and objectives (motivation transversal skills, higher order thinking skills, etc.). This overwhelmingly positive opinion of the latter presents an opportunity that should not be missed for teacher professional development to produce huge benefits and impact. In other words, there is no longer a need to convince teachers and school heads about the relevance of using ICT for T&L, but the need to equip teaching staff with the digitally based teaching competences and experience they need to transform positive opinions into efficient practice in the classroom.

5. Students' skills

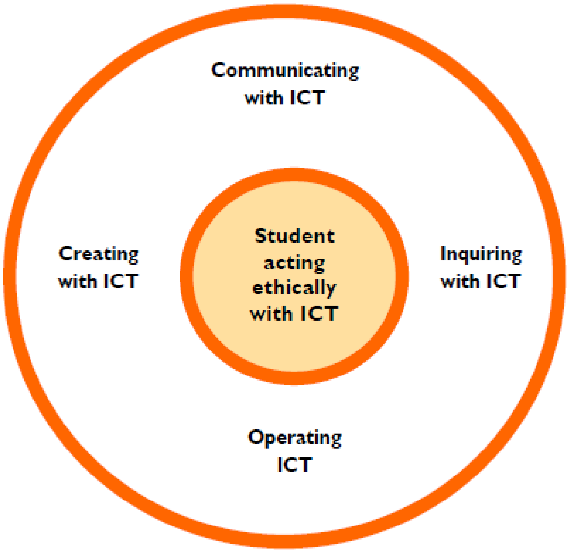
ICT can administer individualized lesson sequences that branch and remediate according to students' unique needs, quickly and automatically track progress, perform data analysis, and generate reports. Other computer-based tools enable teachers to quickly generate individualized communications to parents, create lesson plans, and select instructional materials from a rich resource database. If entire schools or districts use such capabilities, record keeping and communication can be dramatically enhanced.

The use and the understanding of significance of ICT is described in four strands (Fig.11).

- Inquiring with ICT. Students use ICT for inquiry and research. They identify information needs, locate and access information. They organize, use and interpret information to improve their understanding.
- Creating with ICT. Students create ICT products to extend their thinking skills. They analyze ICT problems and needs, develop strategies and evaluate solutions. They use design processes to select appropriate ICT, generate ideas and plans and to monitor and reflect on their learning.
- Communicating with ICT. Students use ICT to enhance communication. They learn to communicate and apply ICT to present information, engage with diverse audiences and collaborate. They communicate face-to-face and remotely with individuals and networks. Students experience and share alternate views, construct new understanding and develop empathy with others.

- Operating ICT. Students gain an understanding of the systems they are operating. Skills in operating one system can be transferred and built upon when operating other systems. They learn to apply ICT standards and conventions. They apply preventative strategies to protect systems and data and solve basic ICT-related problems.

Fig. 11. ICT is described in four strands.



Source: own elaboration

<u>Reasons for using ICT</u>

Some things only teachers can do. Teachers can build strong, productive relationships with students. Technologies can't. Teachers can motivate students to love learning. ICT can't. Teachers can identify and meet students' emotional needs. ICT can't. ICT-based solutions in education can, and must, free the teacher to do the important work that requires human interaction, continuous evaluation, and improvement of the learning environment.

- Students learn and develop at different rates. ICT can individualize instruction.

- Graduates must be proficient at accessing, evaluating, and communicating information. Educational technologies ICT can—by design—provoke students to raise searching questions,
- ICT can foster an increase in the quantity and quality of students' thinking and writing.
- Graduates must solve complex problems. Allow students to independently organize, analyze, interpret, develop, and evaluate their own work. These tools engage students in focused problem solving, allowing them to think through what they want to accomplish, quickly test and retest solution strategies, and immediately display the results.
- ICT can nurture artistic expression.
- Graduates must be globally aware and able to use resources that exist outside the school.
- ICT creates opportunities for students to do meaningful work.
- All students need access to high-level and high-interest courses.
- Students must feel comfortable with the tools of the ICT.
- Schools must increase their productivity and efficiency.

Preparation for further education and lifelong learning

Learners leaving the education system in typical school-leaving years will need proven basic ICT competence that will assist them in finding a job or creating their own businesses. Learners entering higher education also need to be competent in ICT to proceed with confidence. The American workplace requires students who "must learn how to learn, learn how to think, and have a solid understanding of... what it (technology) can do" (STaR Report, http://www.ceoforum.org/). The US Secretary of Labor's Commission on Achieving Necessary Skills (the SCANS report) identifies necessary skills for students.

Necessary student skills:

- to identify, organize, plan and allocate resources;
- to organize and manage themselves and their activities responsibly and effectively;
- to acquire, organize, use, maintain, interpret, communicate as well as use technology to process information;
- to understand the complex inter-relationships and systems;
- to work with and apply a variety of technologies to complete tasks.

There is a strong argument for ICT in schools based on the expected economic impact alone. However, if curriculum reform is allowed to succeed with the support of ICT, learners will develop the lifelong skills that will make them an asset in a global economy. Training that has been provided to schools that have received computer donations in most countries (including developed countries) has largely been inadequate. Training has tended to take the form of generic computer training and teachers have been left unsupported once the training was completed, specifically in how ICT can support teaching and learning. Teachers who learnt how to use certain applications, used these for personal tasks, but did not know how to integrate these tools with the curriculum. The Educators' Network strategy of teacher development for ICT breaks that paradigm and strives to show how ICT can be integrated into the curriculum. It is recommended that staff development in ICT integration, not just the acquisition of ICT skills, should form an integral part of any school ICT project.

6. Summary

Students in Poland tend to be in schools where teacher confidence in ICT is above the EU mean, their use of ICT is close to but below the EU mean (except in vocational schools) and student confidence and use is at or above the EU mean, despite having relatively lower levels of computers, connectivity and connectedness compared to their peers in other countries. This high confidence and use could well be the result of higher than average time spent on ICT professional development than the EU mean, but is possibly hampered by the lack of ICT coordinators in some schools.

Analysis of the data in the Survey of Schools: ICT and education suggests a 5 approach to addressing issues identified in the survey:

1. **Capacity building**, through sustained investment in teachers' professional development.
2. **Concrete support measures**, accompanying specific policies at school level.
3. **Combined policies and actions**, in different policy areas within a systemic approach.
4. **Country-specific support**, addressing large differences and degrees of ICT provision and implementation.
5. **Competence development**: these form actions directed at increasing effectively and dramatically young people's digital competence and the key competences described in the European framework.

The findings of the Survey show that policies and actions relating to infrastructure provision are still needed if most students at all grades are to be in highly digitally equipped schools as defined above. These policies, focused on providing laptops (or tablets, notebooks, etc.) and interactive whiteboards, would help to overcome what is still considered by practitioners as the major obstacle to ICT use. Such policies are a matter of urgency in those countries that lag behind others. At EU level, supporting policies should take into account the very different levels and characteristics of infrastructure provision measured by the Survey depending on the country, developing diversified support actions suited to the most equipped education systems as well as to the less well-equipped ones.

The Survey findings underline the importance of developing ICT use during lessons in school for students to become more confident in their digital competence, regardless of the many opportunities some have to use ICT out of school, and even more fundamentally for those who still lack access to it at home. Increasing the amount of well-designed ICT-based activities in school is the best way to increase the number of digitally confident and supportive students.

1. Focus support on teachers.
2. Bring about inspiring school leadership and support infrastructure development where still needed.
3. Boost the use of ICT at school to build students' confidence in their digital competence.

This paper has outlined the impact that ICT has already had on learning and curriculum reform. It is clear that ICT has had a profound effect on the nature and scope of learning, but it should be noted that where ICT has succeeded, careful planning and implementation over time has been necessary. What has been achieved so far, has been through a coordinated strategy of ICT acquisition, curriculum reform and teacher development.

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