Study of the impact of technology in primary schools

Synthesis Report

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Public Services Contract n° EACEA/2007/4013

steps

CONTENTS

1. INTRODUCTION

After two decades of ICT investment and use in schools across Europe, the relationship between ICT and teaching and learning is an increasing focus for education policy makers, researchers and other education stakeholders, particularly at a time of economic stringency. What impact is ICT having in schools? How can ICT best be harnessed to improve teaching and learning? Which strategies are effective?

The Study of the impact of technology in primary schools (STEPS) set out to find answers to these questions in Europe's primary education systems. Funded by the European Commission, Directorate General Education and Culture, STEPS analyses strategies for the integration of ICT in primary schools in the 27 countries of the European Union, Norway, Liechtenstein and Iceland, their impact and future development perspectives. The study identifies the main impact on learning and learners, on teachers and teaching, as well as on primary school development plans and strategies. STEPS also identifies the main drivers and enablers for effective and efficient use of ICT, leading to recommendations for policy makers and stakeholders.

European Schoolnet (EUN) coordinated the study and worked in partnership with empirica GmbH. The study was carried out between January 2008 and June 2009.

1.1 OVERALL STRUCTURE OF THE STEPS FINAL REPORT

The STEPS final report comprises the following:

- Executive summary
- Synthesis report
- Part 1: Policy survey results and analysis
- Part 2: LearnInd data results and analysis
- Part 3: Literature review analysis
- Part 4: School survey results and analysis
- Part 5: Analysis of the good practices and case studies
- Annex 1: 30 country briefs
- Annex 2: 25 case studies
- Annex 3: Methodology

The results of the different surveys are summarised and presented country by country in 30 country briefs (Annex 1). The school survey analysis contains 123 descriptions of best

practices which were further analysed in 25 case studies (Annex 2). The methodology (Annex 3) sets out the underlying analytical framework, research instruments and contains all the questionnaires and key data.

This report summarises the main findings from the analytical papers and sets out the overall findings and recommendations.

2. METHOD

2.1 DESIGN OF THE STUDY

The STEPS study builds on previous studies in the field of ICT in education carried out by European Schoolnet (EUN) and empirica.

EUN regularly carries out monitoring and research activities in various fields related to ICT in schools such as analysing ICT policies or gathering innovative practices in schools based on a qualitative approach. The ICT impact report - a review of studies on the impact of ICT in education written by EUN in the framework of the European Commission´s ICT cluster - revealed considerable gaps in what is known at a European level about the impact of ICT.

> *"Evidence or access to evidence on the impact of ICT in schools is unevenly spread across Europe. Many of the findings relate to the United Kingdom and to England in particular. They are mostly in English. There are gaps in what is known about other countries. No doubt some evidence exists and efforts should be made to identify it and ensure it is translated. If it does not exist, efforts should be made to support trans-national studies to ensure good coverage and reliable results."* [1]

One aim of the STEPS study is to close this gap and provide a more balanced picture of the impact of ICT on primary education.

Empirica was responsible for the LearnInd survey of 30,000 teachers and head teachers in 27 European countries[2] for the Information Society and Media DG: this provided quantitative evidence on the access and use of ICT in European schools in 2006 generally in primary and secondary education. In this study, the data was specifically analysed with respect to primary education.

STEPS builds on this work. Based on the experience of both organisations in the field and the application of different approaches and methods (quantitative and qualitative) for gathering and analysing developments in ICT in education, EUN and empirica worked in a complementary way to paint a rich portrait of the impact of ICT on primary education.

EUN and empirica worked with over 50 National Correspondents (NCs) in the countries represented to obtain the necessary information to ensure good coverage from across the EU 27, Norway, Liechtenstein and Iceland. The NCs were appointed mainly through the EUN´s network of ministries of education, and empirica´s European Network for Information Society Research (ENIR). The aim was to work with trusted experts to ensure quality and an

[1] Balanskat, A., Blamire, R., Kefala, S., The ICT Impact Report, A review of studies of ICT Impact on schools in Europe. European Schoolnet, 2006.

[2] empirica (2006): Benchmarking Access and Use of ICT in European Schools 2006. Final Report from Head Teacher and Classroom Teacher Surveys in 27 European Countries. Download at http://europa.eu.int/information_society/eeurope/i2010/docs/studies/final_report_3.pdf

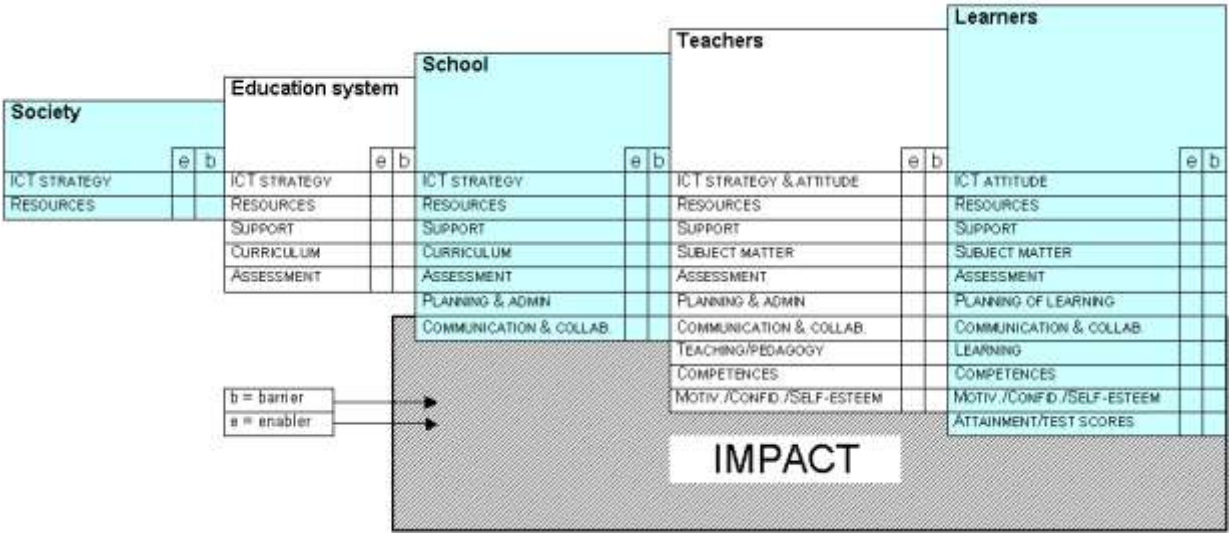
efficient and reliable flow of work. In 15 countries more than one expert was involved, under the supervision of the NC, in order to cover effectively policy, research and practice.

Five quantitative and qualitative surveys and activities were carried out in the EU 27 plus Norway, Liechtenstein and Iceland:

- Policy maker survey to provide an overview of policy approaches to ICT in primary education;
- Teacher and head teacher survey to analyse quantitative evidence from the LearnInd surveys[3];
- Literature review to report on evidence of ICT impact in national and European studies and reports;
- School survey to give qualitative insight into the impact of national strategies in schools, and the identification of good practices via self-reporting;
- Case studies to observe and describe in detail the good practices identified.

2.2 THE STEPS ANALYTICAL FRAMEWORK

The analytical framework is the overarching framework used for the integrated analysis and presentation of the overall findings. The framework visually captures all the elements deemed necessary and represents them in a logical and concise way. The analytical framework is built around a core of teachers, learners, and the schools as a whole. The framework helps to describe the context in which ICT is introduced and implemented.



[3] Korte, W. Hüsing, T., "LearnInd: Benchmarking Access and use of ICT in European Schools 2006", empirica 2006.

The model consists of five levels: society, education system, school, teachers, and learners. These levels represent where strategies, enablers and barriers can be found. The framework reads from left to right, representing not only a hierarchical flow but also a flow from strategy to impact.

2.3 FROM STRATEGY TO IMPACT - UNDERLYING CONCEPTS OF THE STUDY

Strategy and *impact* are the two underlying concepts of the STEPS study. They can be seen as the two ends of a chain: a strategy is always designed with the aim of having impact. Strategies and policies are shaped at several levels, and this makes policy implementation and evaluation a difficult task, especially because they involve attitudinal and work process changes. How do we know whether it was the intervention that made the impact without taking other factors into account? Can change attributed to an ICT strategy be isolated from other factors? How was policy implemented in practice? How do we measure impact?

We can distinguish a number of strategic levels and layers that play a role when looking at the implementation of ICT. Strategies can be found from societal level all the way down to an individual teacher making strategic decisions on when and how to use ICT. These levels include firstly: society at large and how it tackles ICT; and, secondly, the education system (including policy targets and the main actors). The third and fourth layers are formed by governing bodies (e.g. regional or local authorities) and by individual schools. A final layer is the 'end-user': often the teachers, but also the learners themselves. These end-users develop strategies to comply with national, regional and local requirements; and, of course, to satisfy their own targets.

Impact can be described as the overall achievement of an intervention within the educational system and can be described by a variety of qualitative and quantitative indicators such as 'improvements in national test' or 'improved learning in schools' depending on the policy target. It is the end point of an intervention involving input, process, output and outcome. Isolating the variable which actually causes the impact is problematic in education.[4]

Within STEPS we use the following definition of impact: a significant influence or effect of ICT on the measured or perceived quality of (parts of) education. This study is based on the assumption that not all impacts are positive or intended.

It is widely acknowledged that not all policies are implemented as planned and that classroom practices are hard to change[5]. Although evidence about effective strategies has been identified, it must be remembered that policies are generally shaped to local contexts and that practices take a long time to change. Years of ICT impact studies confirm this complex picture. ICT impacts cannot always be measured through test scores - sometimes no gain in test scores can be found and no direct link can be established between an ICT

[4] Balanskat, A., Blamire, R., Kefala, S., The ICT Impact Report, A review of studies of ICT Impact on schools in Europe. European Schoolnet, 2006.

[5] See M. McLaughlin in Lieberman, A. (ed). *The Roots of Educational Change. International handbook of Education Change. Springer. 2005.*

intervention and improved attainment. One solution in this study is to look at impact not only in attainment (hence this study's wide definition of impact) but also to look at how ICTs improve the processes of teaching and learning and within the school.

2.4 MAIN CONSIDERATIONS FOR THIS STUDY

1. Not to confuse major interventions/major changes/impressive innovations with significant effects or vice versa. The smallest of changes introduced by ICT can sometimes result in a major change.

2. It is sometimes the introduction of ICT that causes an impact, rather than ICT itself. In other words: by introducing new technologies, stakeholders sometimes reconsider an existing practice and replace it with a new, better and more effective practice. However, this new practice could have implemented even without ICT. Although this is not bad in itself, we need to be careful about attributing impacts to ICT where the real impact is indirect.

3. Not every impact is the intended impact. This is where strategy and impact meet: there can be unintended side-effects or even negative impacts due to an intervention. It is also possible that there is an impact despite the policy or strategy: there is a clear strategy, there is an impact, but they are unrelated; or they are related but not in a causal way.

4. An additional constraint is the fact that ICT enables the acquisition of competences that are not always measured and accredited by (mostly more traditional) testing methods and assessment schemes. New knowledge and skills or outcomes that are more difficult to measure (such as creativity, innovation, meta-level skills of self-confidence) should not be overlooked in this study as important outcomes.

3. POLICY SURVEY ANALYSIS

The impact of ICT on primary schools, teachers and learners cannot be seen in isolation, but only in its wider educational context. The policy-maker survey specifically looked at the main characteristics of primary education systems in Europe, analysed national policies for ICT in education, educational priorities and the role of ICT and the primary school curricula.

3.1 CHARACTERISTICS OF PRIMARY EDUCATION SYSTEMS IN EUROPE

There are 209,866 primary schools[6] in the 30 countries[7] surveyed, ranging from 14 in Liechtenstein to 55,329 in France. Many of these schools are small and in isolated or rural areas: including, for example 4,285 in France and 1,185 in Finland. Compulsory schooling in the countries covered by STEPS begins between the ages of four to seven. Teacher supply, entry qualifications, conditions of work and salaries vary considerably: for example gross monthly salaries range from €200 (Romania) to €3,195 (Denmark) and among the 21 reporting countries the average was €1,630. Most primary schools are managed, funded and governed by the local municipal councils - and so data tends to be held locally and is not always available. However, even based on fragmented information, a number of core characteristics appear among primary schools in Europe:

- Teachers working at primary level are predominantly female.
- Primary teachers typically stay with one class of children all day.
- Most primary schools are free of exam pressure compared to secondary level.
- Children are in relatively small schools.

A first language, mathematics, science and technology (MST) are the competences most likely to be part of the compulsory primary school curriculum; entrepreneurship is the subject least likely to be taught, but even so appears in the curricula of 12 countries. Digital competence is formally in the curriculum (in various forms) in 22 of the 30 countries.

Rethinking the curriculum, pedagogical and subject change (notably language, science and mathematics), and increasing school autonomy are the major reform topics in the countries surveyed.

The education priorities most frequently mentioned by policy makers as being those where ICT could make a difference were: those addressing management and administration issues, teacher training, low pupil achievement, and communication and collaboration.

[6] A primary school is defined as one that educates children between the ages of four and eleven (ISCED 1[6]). The figures do not include private schools or kindergartens. A number of countries have all-age schools or combine primary and lower secondary schools in one school.

[7] Countries are listed by their standard two letter form.

3.2 ICT POLICIES FOR PRIMARY SCHOOLS

Taking this specific focus on primary schools in terms of their specific environment, subject focus and structure (as compared with secondary schools), the policy survey studied policies for ICT in education including those specifically targeting this education level.

THE MOST COMMON POLICY APPROACH IS TO INCLUDE ICT IN GENERAL EDUCATION POLICY AND TO HAVE A SPECIFIC ICT POLICY FOR ALL SCHOOLS

The commonest policy approach, in 15 countries, is to include ICT in general education policy and to have a specific ICT policy for all schools. Six countries have ICT in their general education policy but no specific education policy for ICT, while four countries (Austria, Netherlands, Poland, and Slovenia) have the opposite. Only eight countries have a specific policy for ICT in primary schools. These are Belgium, Bulgaria, Cyprus, Denmark, France, Portugal, Romania and the United Kingdom. Countries making fewer explicit references to ICT in policies may see ICT as pervasive, but there is also the risk that it is seen as optional. The fact that only eight of the 30 countries have specific policies for ICT in primary schools suggests that primary schools may be missing out on ICT opportunities seized by the larger or perhaps more vociferous secondary schools.

ICT POLICIES USUALLY AIM AT IMPROVING TEACHER COMPETENCE AND INFRASTRUCTURE

All 30 countries in this study have at least one ICT policy or initiative affecting primary schools, and usually aimed at improving teacher competence and infrastructure (on the assumption than improved learning outcomes will follow). Although there is evidence that leadership and changing educational culture and pedagogy bring about the most effective conditions for ICT use and impact, few strategies target leadership and change in educational culture. It is interesting to note that one of the most frequently reported impacts of ICT in primary schools, and reasons for using ICT, is increased pupil motivation and engagement. Yet if this is mentioned as a target, it is restricted to disengaged pupils or those with learning difficulties. The use of ICT to improve the management and administration of schools is less complex and benefits from such deployment are more proven than using ICT in teaching and learning. However, few ICT policies refer to this ‘easy way’ of modernising the administration and management of schools, let alone re-engineering ‘business processes’ in schools, as is happening in other economic sectors.

POLICIES TO REFORM THE CURRICULUM, PEDAGOGY AND ASSESSMENT ARE UNCOMMON

Policies to reform the curriculum, pedagogy and assessment are uncommon, despite the fact that they are as important a success factor as infrastructure, subject content and teacher education and technical support. Strategies focus on inputs and intermediate outcomes within the system rather than improving children’s learning, which is a major impact area.

ICT in schools is a topic that continues to arouse controversy, and the level of controversy may increase as the global recession bites and budgets are reduced. It is important that interventions and changes are based on evidence. Advocacy – making a reasoned case – is

important in winning over hearts and minds and obtaining 'buy-in'. The engagement of parents, employers, the media, politicians and the wider community is important to articulate expectations, support the schools, and apply pressure for ICT change. Where the debate involves the general public, concerns tend to be about e-safety in various forms.

3.3 ICT RESPONSIBILITY AND SCHOOL AUTONOMY

SCHOOLS OR MUNICIPALITIES HAVE INCREASING AUTONOMY AND ACCOUNTABILITY

Schools have increasing autonomy and accountability, but, in most countries, much decision-making and planning is made at national or municipal / town council levels.

Primary schools (and the procurement of ICT products and services) are largely the responsibilities of municipalities in many countries, the ministry of education playing virtually no role. Such a situation might cause confusion and a lack of direction as there may be two or more bodies responsible for in-service teacher training and support for ICT. In a minority of countries, there are primary school ICT co-ordinators whose role, provided they are supported and their tasks differentiated between technical support and pedagogical support, can be effective. Clustering schools and creating ICT groups within schools can reduce isolation and the 'lone enthusiast' syndrome.

The general tendency is for the curriculum, or part of it, to remain centrally defined, and other aspects to be decentralised. Schools or municipalities have increasing autonomy and accountability, but in most countries much decision-making and planning is still at national or municipal/town council level. Primary schools are part of a system. Responsibilities for ICT vary and are sometimes unclear: hardware provision is often separated from content procurement, maintenance and pedagogical support. Although schools have increasing autonomy in reaching externally set targets, little evidence was found that they have specific plans to achieve these targets. Countries in which primary schools have specific ICT development plans are Finland, Malta, the Netherlands and the UK. There appears to be little support for schools and municipalities in managing and monitoring their new decision-making powers in these areas.

These findings contribute to the formulation of the following recommendation:

> Recommendation 2. (Policy Makers): Build ICT into general educational policies, including assessment

3.4 RESOURCES AND DEPLOYMENT POLICIES FOR ICT IN PRIMARY SCHOOLS

COMPUTERS IN THE CLASSROOM ARE A REALITY IN SOME COUNTRIES, OTHERS STILL RELY ON COMPUTER LABS

There is a split in the policy survey analysis on the issue of whether computers should be distributed in classrooms or clustered in labs, but it appears that the countries with high

levels of ICT favour dispersion into classrooms. Countries favouring this approach (according to the policy survey) are Austria, Greece, Lithuania, the Netherlands, Malta, Cyprus, Norway, Finland, Denmark and the UK.

More precisely, the quantitative survey reveals that 68% of European primary schools have introduced computers in classrooms, with some variation among countries. In Luxembourg, Slovenia, the United Kingdom, the Netherlands, Cyprus and Ireland this is the case in more than 90% of primary schools. In contrast, there are ten countries where less than half of schools have computers in classrooms. In these countries, the majority of primary schools use computers for education in dedicated computer labs. However, countries with classroom computers may in many cases also have computer labs.

SPECIFIC ICT AS AN ESSENTIAL TOOL FOR INTEGRATION

The interactive whiteboard appears to be an essential tool in the primary classroom in some countries, notably the UK, DK and NL, but not in others, such as Finland for example. Cost is part of the argument and the pedagogical approach may also be an issue. Evidence from other work points to this being a rapidly evolving situation, with some major pilots currently underway which will significantly increase the number of interactive whiteboards. There is a clear trend towards laptop purchase in primary schools, probably because of their greater versatility and smaller footprint. Denmark, Estonia and Norway have the highest levels of learning platform use. Denmark, Estonia and Italy offer access to parents, teachers and children from outside school. Denmark and Norway have evaluated their use.

These findings contribute to the formulation of the following recommendation:

> Recommendation 3. (Policy makers): Ensure effective and equal access to quality equipment and digital learning resources

3.5 TEACHER EDUCATION AND ICT SUPPORT

TEACHERS ENTERING THE PROFESSION HAVE LITTLE FORMAL TRAINING IN ICT USE

Teachers entering the profession may have little formal training in using ICT in teaching in a significant number of countries, owing to lack of equipment or experienced trainers, training being unrelated to day-to-day practice, or the absence of ICT in courses. The autonomy of training institutions can lead to uneven rates of effective integration of ICT across a system.

Countries are investing in developing the ICT skills of serving teachers. Yet interventions are not always system-wide or effective. There appears to be little classroom-based in-service training, little encouragement of communities of practice, few online opportunities or specific measures aimed at school leaders. The content of training may fail to match needs and lacks the pedagogical and practical dimension.

These findings contribute to the formulation of the following recommendations:

Recommendation 1. (Policy Makers): Improve, diversify and certify ICT teacher education and support head teachers as leaders of change.

Recommendation 5. (Headteachers and teachers): Strengthen the pedagogical use of ICT and develop an open, knowledge sharing school culture.

4. QUANTITATIVE EVIDENCE ON THE USE AND IMPACT OF ICT

According to the quantitative survey of 12,379 teachers and 6,449 head teachers (LearnInd survey) in 26 European countries, most teachers in European primary schools are optimistic about the impact of ICT on learning. While there are very few die-hard impact sceptics, the group of optimists can be divided into the impact 'euphoric' and the more reserved optimists. The distribution of these types cannot satisfactorily be explained by the status quo of ICT use and strategies in the various countries. Impact-euphoric teachers dominate in countries as diverse as the United Kingdom, Cyprus, the Netherlands, Portugal and Poland; while reserved impact optimists are predominant in countries as diverse as Sweden, France and Austria. The findings are summarised below.

4.1 USE OF ICT IN CLASS AND FOR EDUCATIONAL PURPOSES

VIRTUALLY ALL PRIMARY SCHOOLS USE COMPUTERS WITH DIFFERENT LEVELS OF SOPHISTICATION IN DEPLOYMENT BUT THERE IS BROAD CONSENSUS ABOUT POSITIVE IMPACT OF ICT

Some 75% of primary teachers use computers in class - with a variation in rates from around 90% in the Nordic countries to around 35% in Greece, Latvia and Hungary. Almost all of the teachers using ICT in class involve pupils in using the computers.

There is an amazingly widespread consensus about the positive impact of ICT among primary school teachers across Europe. About 87% say that pupils are more motivated and attentive; while only 21% believe that using computers in class does not have significant learning benefits.

NO DIFFERENTIATION OF BENEFITS OF ICT IN 'MODERN' AND 'TRADITIONAL' TEACHING PRACTICE

Teachers consider that ICT supports both 'traditional' teaching practices (exercises and practice, office tools) and more 'modern' practices (self-directed learning, collaborative work); no differentiation in the assessment of teachers is found empirically.

These findings contribute to the formulation of the following recommendation:

> Recommendation 6. (Headteachers and teachers): Exploit the potential of ICT as a catalyst for change and to fulfil educational goals.

4.2 ICT AND THE CURRICULUM

TEACHING COMPUTER SCIENCE VERSUS INTEGRATING ICT IN ALL SUBJECTS

ICT is integrated in the primary school curriculum in almost all countries. There is a split between countries as to whether ICT should be taught as a separate subject in primary schools. ICT is not taught as a separate subject in 15 countries, while it is taught as a subject in 11.

The incidence of teaching of computer science as a separate subject varies across Europe, with an average of 48%, ranging from being taught in nearly all schools in Latvia, Poland and Hungary to very few schools in Finland (19%) and Austria (9%).

Generally speaking, in some of the countries where many schools offer computer science as a separate subject, computers and the internet also seem to be more integrated into the teaching of other subjects. A good example is the Czech Republic, where 72% of primary schools offer computer science as a separate subject, but at the same time, computers are also used in other subjects in 71% of Czech primary schools. Similar practice is also found in Estonia (84% and 82%), Lithuania (86% and 83%) and Slovenia (88% and 82%). There is therefore little evidence to suggest that teaching computer science as a separate subject implies placing less importance on ICT in other subjects.

ICT IN FOREIGN LANGUAGES AND IN BASIC SKILLS CLASSES

As for specific subjects, ICT is of significant importance in teaching foreign languages (52%) and teaching or basic skills (80%). As for foreign languages, the countries which are frontrunners are Denmark (96%), Iceland, Slovenia and Estonia; while Ireland, France, Belgium and the United Kingdom are at the other end of the scale. With regard to basic skills, Hungary, Latvia and Greece make the least use of ICT, while Sweden, Denmark and Norway take the lead.

DIFFERENT STRATEGIES WITH REGARD TO LEARNING MATERIAL

Different strategies can be found as to the source of learning material that teachers use. In total, 82% of primary school teachers who use computers for teaching use material they have found on the internet: whereas 76% use material available online from established sources, and 64% use material from the school's computer network or database. Offline material is used by 85% of teachers who use computers and 7% of teachers use other offline material.

4.3 TEACHERS' ATTITUDE TOWARDS ICT USE

TEACHERS IN SOME COUNTRIES ARE MORE OPTIMISTIC THAN OTHERS

Countries line up in two separate groups in terms of their support for ICT use for various teaching purposes on the one hand and of their optimism about benefits on the other. The countries most optimistic about ICT use are Malta, Poland, Cyprus, the United Kingdom and Portugal; while the least optimistic countries are Iceland, France, Luxembourg, Sweden and Belgium. On the second issue, countries most supportive of broad use of ICT in many subjects are Slovakia, Spain, the United Kingdom, the Czech Republic and the Netherlands, while Luxembourg, Italy, Greece, Slovenia and Norway are the least supportive in this regard.

However, it has to be stressed that there are hardly any teachers who voice outright opposition to the use of ICT in class.

LITTLE OR NO CORRELATION BETWEEN IMPACT OPTIMISM AND LEVEL OF SCHOOL EQUIPMENT, SOPHISTICATION OF USE, OR EVEN TEACHER SKILLS

There is little statistical correlation between the overall level of impact enthusiasm or scepticism and the technical opportunities prevailing at primary schools. By and large, there are similar incidences of scepticism and optimism in those countries where schools are generally well equipped as in those where schools tend to be less well equipped.

The same holds true for the overall level of ICT deployment. Again, there are optimist countries such as Greece, Hungary, Poland and Portugal with comparably low levels of ICT deployment; and there are countries like Finland, Sweden and Iceland with low optimism levels despite widespread use of ICT.

4.4 CLUSTER ANALYSIS OF COUNTRIES

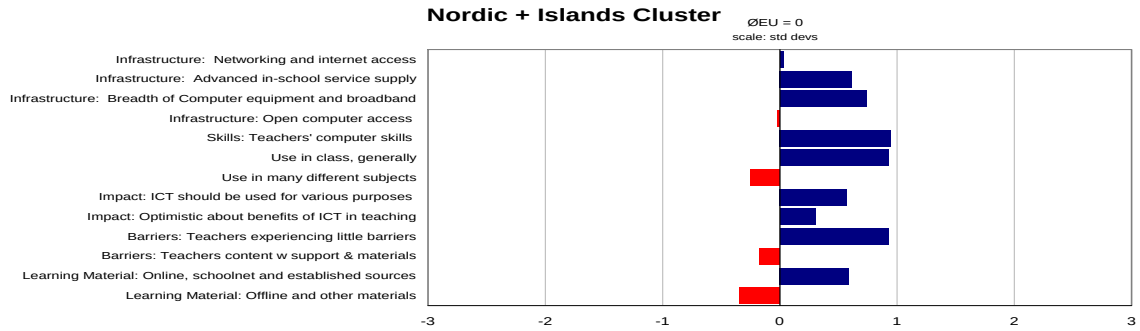
A clustering of the different dimensions of ICT use leads to a classification of similar and dissimilar countries. Five clusters emerge as follows:

- "Nordic countries and Islands" (blue)
- "Eastern and Southern European" (yellow)
- "German-speaking" (green)
- "Western continental" (orange)
- "Greece and Latvia" (red)

THE "NORDIC COUNTRIES AND ISLANDS" CLUSTER

This cluster consists of all the Nordic countries, the Netherlands, the UK, Ireland, Cyprus and Malta. These countries are clearly the frontrunners with regard to ICT deployment in primary schools.

Exhibit 0-1 Cluster profiles: the "Nordic countries and Islands" cluster

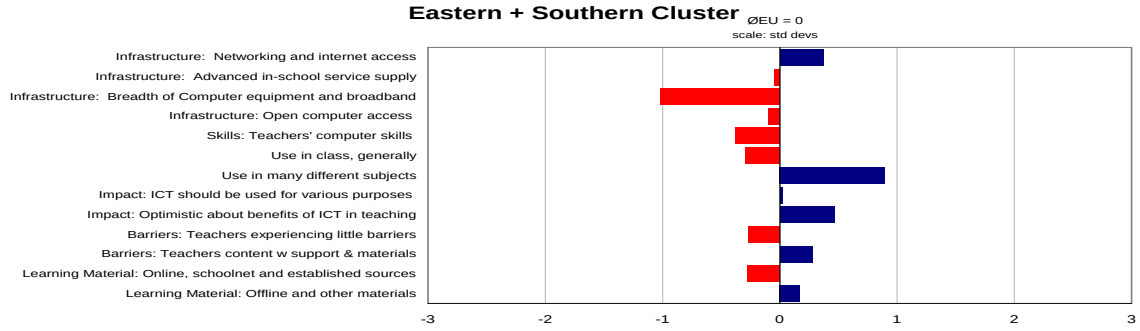


Teachers are highly skilled and the whole environment is positive about ICT, resulting in teachers perceiving the fewest barriers to effectively using IT in class. On average, schools are excellently equipped and have broadband. The use of in-school networking, however, is only at an average level, and this is partially because some teachers only mildly agree with the equipment level and connection speed in schools. However, teachers use ICT to a great extent in class, and use online materials. The factor with the most negative score is "use of offline material", arguably a consequence of a good online supply.

THE "EASTERN AND SOUTHERN" CLUSTER

This cluster consists of the Czech Republic, Slovakia, Poland, Hungary, Slovenia, Lithuania, Estonia, Spain and Italy. These countries are especially enthusiastic about the use of IT in class, and offer above average computer science classes; as well as ICT-supported language learning. They also have above average networking and internet access facilities; however, they score rather poorly on computer equipment in schools (number of PCs, computers outside labs). Teachers use ICT in class at a below average level, and skills remain a challenge. Those teachers using ICT make use of offline rather than online materials.

Exhibit 0-2 Cluster profiles: the "Eastern and Southern" cluster

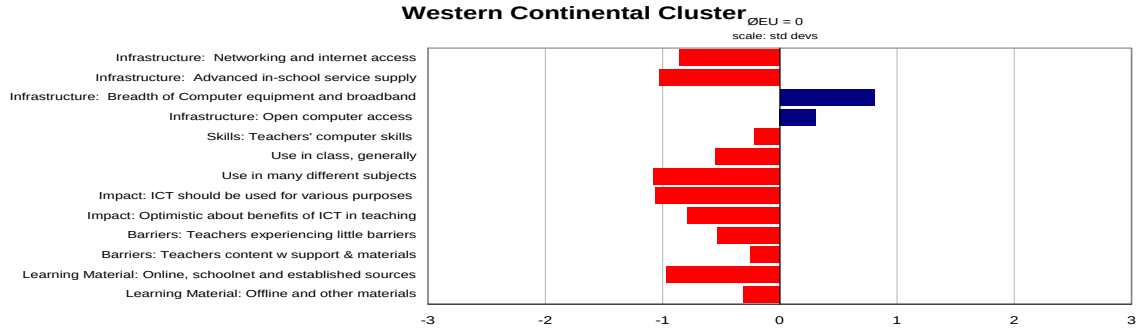


THE "WESTERN CONTINENTAL" CLUSTER

This cluster consists of France, Belgium, Luxemburg and Portugal. These countries still face a number of challenges with regard to broader ICT deployment in primary schools. The

dimensions with above average scores are "computer equipment" and "open access", pointing to a generally good infrastructure with regard to the number of computers available, even in classrooms and other openly accessible places. However, infrastructure challenges relate to internet access and broadband, in-school networking, e-mail addresses, school websites and external service contracts. Teachers use ICT in class at a lower than average extent, and they are on average less skilled than their European neighbours. Teachers experience more barriers, they are less satisfied with the material available, and also less optimistic about the impact ICT can have on learning successfully.

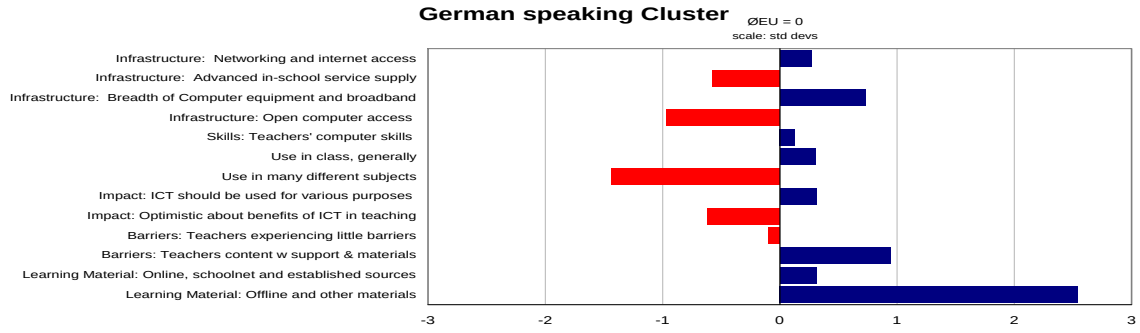
Exhibit 0-3 Cluster profiles: the “Western continental” cluster



THE "GERMAN SPEAKING" CLUSTER

This cluster consists of Austria and Germany. The profile reveals a rather mixed "performance" with some positive and some negative highlights. German and Austrian teachers are heavy users of offline teaching materials such as CD-ROMs. Teachers are also relatively satisfied with support and materials at their schools. General equipment with computer terminals is above average, as is school connectivity. Open access to computers by pupils (in libraries or other places), however, is less common in Germany and Austria and below the European average. Also, use of ICT in teaching languages and computer sciences is significantly below the European average.

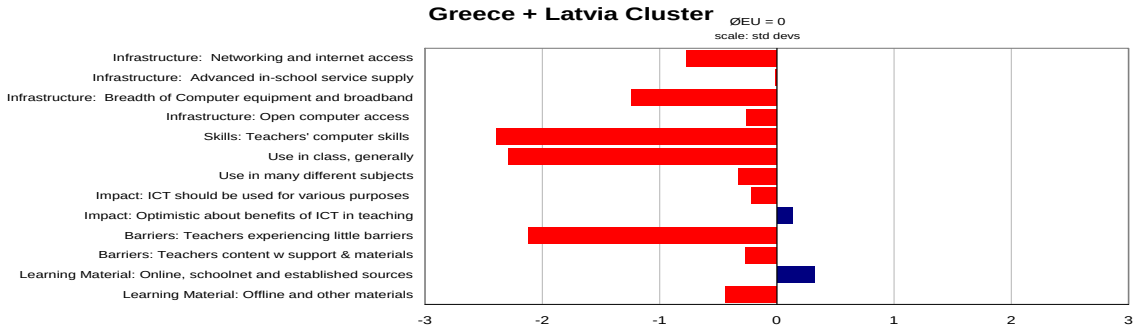
Exhibit 0-4 Cluster profiles: the "German speaking" cluster



THE "GREECE AND LATVIA" CLUSTER

The last cluster is made up of only two countries, Greece and Latvia, which represent statistical outliers with generally below average scores. Positive items include optimism about ICT impact and the use of online materials by teachers who use ICT in teaching. It is apparent that teachers in Greece and Latvia are not highly skilled in ICT; they use it very little in class and experience a number of barriers.

Exhibit 0-5 Cluster profiles: the "Greece and Latvia" cluster



Source: LearnInd Classroom Teacher and Head teacher Survey 2006.

These findings contribute to the formulation of the following recommendation:

> Recommendation 3. (Policy Makers): Ensure effective and equal access to quality equipment and digital learning resources.

5. LITERATURE REVIEW RESULTS - EVIDENCE FROM NATIONAL AND EUROPEAN STUDIES

More than 60 studies from the countries surveyed were reviewed. They report mainly on nation- or region-wide findings for the specific country or region. Furthermore, comparative international studies covering multiple countries were analysed where relevant. The main findings from the evidence are summarized in the following section under the headings learners, teachers and schools.

5.1 IMPACT ON LEARNERS

STUDENTS' USE OF ICT AT HOME AS OPPOSED TO SCHOOL

Students use ICT more frequently at home than at school and perceive an underuse of ICT in schools. There is a huge discrepancy between home and school use of ICT by children in terms of the way they use ICT, for what kind of purposes and activities, access to computers and Internet, and frequency of use. Students are highly motivated to use ICT but "official" education activities with ICT are less motivational.

Motivational factors for using ICT in schools include: greater diversity of tasks, open-ended tasks, discovery and inquiry-based tasks offering opportunities to investigate and produce with the help of ICT rather than highly structured exercises. These factors motivate students and support the learning process.

STUDENT SKILLS AND COMPETENCES

ICT has impacts on the variety of skills and key competencies developed, but pupils in primary schools can lack basic ICT skills. Studies report on a variety of different skills and competencies acquired by using ICT, ranging from digital literacy (defined as being able to access, integrate and create information) to spatial and orientation skills, as well as representation and communication abilities. ICT also plays an important role in the development of basic skills, which is not surprising for primary schools. However, some large national studies show that learners lack or have deficient basic ICT skills, e.g. not knowing how to create a presentation, use a spreadsheet, or send an attachment with an email message.

These findings contribute to the formulation of the following recommendations:

> Recommendation 4. (Headteachers and teachers): Capitalise on children's ICT competence and reduce digital divides.
>
> Recommendation 8. (Research): Shift the focus of research towards the learner and the school as a learning organisation.

ASSESSMENT OF ICT IMPACT

The majority of studies of the impact of ICT on learners base their findings on the perception of students and teachers (perceived impact); as opposed to measuring the impact of ICT via control groups (real) impact. The focus of the first series of studies is more on the learning process, whereas studies using control groups look at student outcomes in tests.

ICT AND LEARNING OUTCOMES

There is little evidence on the impact of ICT on learning outcomes. Studies from Hungary show that ICT-rich constructivist learning environments improve student learning outcomes - especially for students from poor areas and students from a different culture who are starting from a very low level. Evidence from the UK shows that ICT has a positive impact on language development, particularly in the early stages. Interactive whiteboards have raised attainment levels for Key Stage 1 in the UK in maths, science and English, benefiting different groups of learners (girls, boys, average and high attaining pupils). In the Netherlands digital picture books help children to develop language skills.

These findings contribute to the formulation of the following recommendation:

> Recommendation 7. (Research): Apply a variety of methods to measure and assess the impact of ICT.

ICT AND LEARNING

ICT impacts positively on the learning process and achieves wider educational goals. ICT is perceived to have a positive impact on the learning situation, resulting in better understanding and more active and differentiated learning. Teachers already turn to advantage the motivational factor of ICT, as shown by the evidence on fulfilling wider educational goals, maintaining attendance and discipline, and raising motivation and interest in specific subjects or other ICT-based activities.

These findings contribute to the formulation of the following recommendation:

> Recommendation 6. (Headteachers and teachers): Exploit the potential of ICT as a catalyst for change and to fulfil educational goals

5.2 IMPACT ON TEACHERS

TEACHERS´ ATTITUDES AND USE OF ICT

There is a discrepancy between a positive opinion of the potential impact of ICT and its actual use by teachers. Teachers are ICT optimists and aware of the potential benefits for

students for active autonomous learning and creating authentic tasks and personalised learning. However, teachers may lack the pedagogical vision to integrate ICT into classroom teaching and to maximize the pedagogical usefulness of ICT. Studies identify a number of factors, such as experience and skills that influence how teachers integrate ICT into lessons. There is a positive correlation between confidence and experience on the one hand and collaborative, project-oriented and experimental use of ICT on the other.

There is evidence from a large number of studies that teachers use ICT for administration, organisation and planning, especially in Austria, Estonia, Denmark, Finland, Ireland, and Norway, where this issue was studied. There is little evidence about the use of ICT within specific subjects and the process of integrating ICT into teaching and learning.

TEACHERS PROFESSIONAL DEVELOPMENT

Evaluation of teacher training programmes is high on the agenda in various countries. ICT is an important tool for the professional development of teachers. There is a continuous need for teacher training at all stages (initial and continuous professional development) as a high number of teacher training evaluations demonstrate. There is conflicting evidence as to whether generic ICT training programmes are better suited than topic-specific programmes, where as specific ICT use is dealt with, whether on-site training is preferable to off-site training. Some studies recommend maintaining both types of training systems as different types of teachers need different types of support.

TEACHERS' SKILLS AND COMPETENCIES

There is a lack of pedagogical vision regarding the integration of ICT in the teaching and learning process. Teachers in primary schools still do not extensively offer the kind of activities that have proven successful when learning with ICT, namely semi-structured activities that encourage investigation, production and discovery-based learning - coupled with accompanied or promoted independence. Primary schools are focused on the development of child competence and - usually have greater freedom in this area than secondary schools - which are subject to greater pressures such as content, examinations and curriculum constraints. However, the general shift to this new learning paradigm has not yet become everyday practice.

These findings contribute to the formulation of the following recommendation:

> Recommendation 1. (Policy Makers): Improve, diversify and certify ICT teacher education and support
>
> Recommendation 5. (Headteachers and teachers): Strengthen the pedagogical use of ICT and develop an open, knowledge sharing school culture.

5.3 IMPACT ON SCHOOLS

ICT DEPLOYMENT

Studies still focus to a large extent on the availability of ICT infrastructure and resources, albeit with an increased focus on progress made, the quality of access, infrastructure and resources, and also problem areas. Smaller primary schools can be disadvantaged in terms of equipment. Several studies plead for integrated use of ICT by putting computers in classrooms and integrating ICT within subject teaching in order to successfully change teaching practices. There is hardly any evidence of the impact of ICT in schools in areas such as external and internal school collaboration, or on the interdisciplinary and innovative use of ICT within projects.

These findings contribute to the formulation of the following recommendations:

> Recommendation 3. (Policy Makers): Ensure effective and equal access to quality equipment and digital learning resources.
>
> Recommendation 8. (Research): Shift the focus of research towards the learner and the school as a learning organisation.

ICT PLANNING AND SUPPORT

The use of ICT as part of a school-wide plan is rarely researched and we do not know from the body of evidence if these practices are under-represented, or simply not yet the focus of national research. One important element for the successful integration of ICT into the curriculum as part of a whole school approach, specifically in countries where schools have significant autonomy, is the need for a main supporter, preferably the head teacher. Support from the bottom-up is also important, driven by ICT-enthusiast teachers and coupled with practical guidelines for ICT integration.

THE USE OF VIRTUAL LEARNING ENVIRONMENTS

The main impact of virtual learning environments in countries where they have been introduced on a wider scale remains limited in pedagogical terms, and research stresses that teachers need enough time to fully exploit such systems. In terms of communication and knowledge sharing, these systems have less impact on primary schools than secondary schools. However, primary schools tend to use ICT more for direct communication with parents than secondary schools. The use of digital resources by teachers, an important area for the take-up of ICT, was not the focus of national studies under review. With regard to ICT planning and support, the picture remains incomplete and patchy in terms of the studies under review.

These findings contribute to the formulation of the following recommendation:

Recommendation 5. (Headteacher and teacher): Strengthen the pedagogical use of ICT and develop an open, knowledge sharing school culture.

6. SCHOOL SURVEY RESULTS AND ANALYSIS

The STEPS school survey was designed to supplement the core elements of the study – national ICT strategies (policy-maker perspective), studies about ICT impact (research perspective), empirical data (teachers and head teachers in 2006) and case studies (school and external expert perspective) – by providing an up-to-date snapshot of good practices with ICT in the 30 countries in STEPS and the perceptions of the teachers who achieved them. The survey adds the recent voice of teachers and their self-selected good practices with ICT, to give a grassroots dimension to the picture of ICT's impact in primary schools.

There were 257 responses to the survey, at least one from each of the 30 countries in the study and more than five in nineteen countries. The highest response rate was in Greece, followed by Spain, Ireland, Slovenia and Poland.

6.1 ABOUT THE GOOD PRACTICE

ISSUES TACKLED

Respondents were asked to choose from a list those issues that prompted the good practice. *Disengagement, Heterogeneity* (i.e. children from varied backgrounds), *Low attainment, Motivation, Maths, science and technology, Personalised learning, Small school, Curriculum coverage,* and *Remote location of school*.

The most common reason chosen for using ICT in the good practice was to boost pupils' motivation, identified by 26.4% of respondents.

Issues related to curriculum coverage, and maths, science and technology teaching, obtained 22.3% of the answers. Problematic learning, which includes disengagement, heterogeneity and low attainment, is mentioned in 15.4% of the answers. Low attainment per se was highlighted in just 4.6% of responses, especially in view of the fact that this is the 'bottom line' of this study. Personalised learning was cited by 15% of respondents. A difficult context (e.g. a small school, remote location) is another challenge for which ICT is used (12.7%). ICT is used to address other issues in 8% of cases.

A problematic learning process and personalised learning can be clustered, because both relate to improving the learning process; furthermore they are related to encouraging pupils to engage in learning – in other words the question of motivation again, further strengthening the value placed on ICT as a motivator. This, together with the low value given to low attainment, implies that it is indicators of motivation that should be interpreted as evidence of the success of the good practice, not increased test scores.

The issues highlighted by teachers may however be retrospective. There is not a strong thread running from issue to formulation of intervention, to measuring impact and reflecting on variables affecting it; many teachers in daily contact with their children find it difficult to

gain a 'helicopter view' of their practice in lesson after lesson during a busy day. ICT for many is opportunistic and ad hoc.

TYPE OF ACTIVITY

Respondents were presented with eight types of learning activities: the 8LEM taxonomy developed at the University of Liège, Belgium[8] to assist teachers in reflecting on learner activity:

- **Receiving**: this is the traditional didactic transmission of information, for example listening to a lecture or watching a video clip
- **Imitating** : this is learning from observation and imitation, for example repeating a question in a foreign language or a movement in dance
- **Practising**: application of theory and its assessment, for example completing similar calculations in mathematics or repeating a sequence of tasks in science
- **Exploring**: personal exploration by the learner, for example visiting a series of internet sites to satisfy one's curiosity about how ancient people lived or walking through a nature reserve
- **Experimenting**: manipulating the environment to test personal hypotheses, as in a controlled experiment in science
- **Debating**: learning through social interactions, collaborative, challenging discussions, for example in a class discussion about violence in schools
- **Creating**: creating something new, producing work, as when working in art studio or writing a poem
- **Meta-learning**: self-reflection, when the learner thinks about their learning, preferred styles of learning, their own type of intelligence.

There is no single prominent activity conducted through the use of ICT, but a range of different types of activities: creating and exploring are both around 15.5%, learning to learn 14.4%, debating and practising both around 13%, imitating and receiving both 10.5% and experimenting 6.7%.

However, as a general trend those activities involving pro-activity (exploration, creativity, debating, learning to learn) are the most frequently mentioned (almost 59%), while those more linked to traditional pedagogy (imitating, receiving and practising) are mentioned less (34.5%). Experimenting (manipulating the environment to test hypothesis, science laboratory), is featured in only 6.7% of examples.

8 www.labset.net/media/prod/8LEM.pdf

In the good practices described by respondents, various forms of active and open learning (creating, debating, experimenting, exploring) occur far more frequently than more passive and closed activities (receiving, imitating, practising).

These findings contribute to the formulation of the following recommendations:

Recommendation 4. (Headteachers and teachers): Capitalise on children's ICT competence and reduce digital divides.

Recommendation 5. (Headteachers and teachers): Strengthen the pedagogical use of ICT and develop an open, knowledge sharing school culture.

7. ANALYSIS OF GOOD PRACTICES AND CASE STUDIES

The 25 case studies analysed have been derived from the good practice examples identified and selected from the school survey. The case studies inform about the strategies of policy-makers, schools and teachers - and how they impacted on teaching and learning. The purpose of the case studies was also to find out more about the effective use of ICT and identify enablers or barriers at different levels of the education system. In most cases, the case studies were related to a specific application of ICT or a project – and identified by the schools themselves as examples of a good practice.

7.1 LEARNERS

LEARNING AND ACHIEVEMENT

The 38 mentions of positive impact on pupil learning provide important testimony. Schools found it hard to identify direct gains in test scores, but in all schools there was acknowledgement of the many ways that ICT helps children understand the subject they are studying and engage with what is being taught.

A first group of impacts that emerges from the studies is where ICT has impacted on group processes and collaborative learning. These pedagogies have been very common in primary schools across Europe. Teachers state that they like the way ICT supports these pedagogies.

A second cluster of impacts is where ICT helps in catering for individual needs. It can help both slow and more advanced learners. Teachers use special software for dyslexic children. The use of multimedia can stimulate speech development for example, as the learning environment can be enriched through ICT - if used well.

A third area of impact is in improved links between learning inside and outside school. This means that achievements outside school can be identified, and learning is not bound to school hours (in some cases, pupils worked with pleasure on assignments outside school hours). It is also important that this approach helps children perceive less of a disconnect between home and school.

Learning platforms and portfolios help teachers keep track of more dispersed learning process both generally and for individual learners. Assessment systems can even help in giving more sophisticated feedback on pupil performance, e.g. through the analysis of test scores. The case studies offer very little evidence of direct impact on test scores. This is not to say that there is no such impact, but that schools find it hard to pin down ICT's contribution to increased test scores amongst all the other factors that influence them. There are three other possible explanations of why schools have not been able to evaluate the impact of ICT on attainment:

1. In many cases, the main reason for the introduction of ICT was not low test scores as such but rather to improve involvement, or redesign the curriculum or pedagogies (with the underlying assumption that these would improve the achievement and attainment);

2. Few schools have a clear ICT policy paper, which would logically be the document in which to set goals and describe how these goals should be evaluated;

3. The use of ICT might have greater impact in areas that are not covered in current assessment schemes and national tests.

These findings contribute to the formulation of the following recommendations:

Recommendation 5. (Headteacher and teacher): Strengthen the pedagogical use of ICT and develop an open, knowledge sharing school culture

Recommendation 7. (Research): Apply a variety of methods to measure and assess the impact of ICT

Recommendation 9. (Research): Establish a long term and continuous monitoring system on the effects and impact of ICT in schools

COMPETENCES AND ATTITUDES TOWARDS LEARNING

In one school, improvement of reading skills was observed and supported by test scores, and another school enjoyed a substantial improvement in reading, mathematics and visual skills. Other case studies confirm that the evaluation of ICT impact on attainment is an area where many schools still need to make improvements. All of this does not imply that ICT does not impact on pupil competences. Many schools observe that through improved learning with ICT, skills improve as well. In some cases, traditional competences such as literacy and numeracy had been improving. But ICT also has an impact on creativity, interpersonal skills, information skills, and innovation. Most schools report that the skill sets of pupils are widening.

In one case, there was a warning against allowing pupils to remain superficial: the high speed nature of ICT might prevent pupils from really interacting with subject matter. This view contrasts with that prevailing in a number of other schools which report that the interaction with learning matter has deepened. The latter is supported by the fact that there are 25 mentions of pupils becoming more motivated and confident through their own, or the teacher's, use of ICT. This motivation leads, in the opinion of teachers, to better learning and greater commitment to learning.

These findings contribute to the formulation of the following recommendation:

> Recommendation 4. (Headteachers and teachers): Capitalise on children's ICT competence and reduce digital divides.

7.2 TEACHERS

MOTIVATION AND CONFIDENCE

For teachers, ICT plays an important role in increasing their own motivation and confidence. In the case studies, many teachers mentioned that they felt ICT helped them regain interest in certain subjects and regain self-confidence and professional self-esteem. Although there is evidence that ICT does not necessarily make the work of teachers less time-consuming, it is clear that - in the view of the teachers interviewed - this is outweighed by renewed enthusiasm. Many teachers also indicate that their motivation increases when they see the pupil's motivation increasing through ICT. This increased motivation of teachers through ICT cannot be seen in isolation: it is clear that in many of these cases, the introduction of ICT occurred alongside a school-wide or a personal reappraisal of many things: use of resources, pedagogies, and role of teachers.

Certain limits are however clear from one case study which may be indicative of how other teachers experience the introduction of ICT: when there are too many tasks in a teacher's work programme and when ICT is enforced top-down and on top of existing tasks, ICT can become a real burden - even when teachers are enthusiastic about its potential. ICT can aggravate a high workload: especially when there is a lack of coordination or in small schools. In cases where this is not a problem, schools manage time better, support teachers more, value the work of innovative teachers, and have greater scope for experimentation.

WORKING AND TEACHING PRACTICES

Communication and collaboration are important: teaching can be a relatively isolated profession and the opportunity ICT gives to communicate with other teachers - especially outside their own school - and exchange ideas is important and without ICT could only be organised with greater expense of time and money. Teachers are being given a sense of being part of a network of shared knowledge.

Teachers feel ICT has much to offer in terms of their teaching practice. Although the lessons observed were often apparently quite normal with a teacher giving instruction at the front of the classroom, on closer inspection, ICT was enriching this familiar setting. Many of the advantages claimed for ICT were observed: ICT can help make teaching more dynamic by speeding up lessons – e.g. teachers have all the material available with help of an IWB and spend less time arranging materials during the lesson. Dynamism is also created as teachers involve pupils through the use of multimedia and multiple sources. The visual power of ICT can help teachers focus pupil attention by making instruction more realistic.

In three cases, impact was observed in the important area of assessment: the use of portfolios and VLEs gave teachers greater insight into pupil progress and into what motivated them. Planning and administrative software can also help teachers identify and recordi problems. In several cases, it was reported that ICT had improved the day-to-day planning of teachers.

These findings contribute to the formulation of the following recommendation:

> Recommendation 5. (Headteachers and teachers): Strengthen the pedagogical use of ICT and develop an open, knowledge sharing school culture.

7.3 SCHOOLS

STRATEGY AND PLANNING

Impact on school strategies does not feature prominently in the case study reports. However, from the descriptions of the contexts of the school it seems clear that ICT usually impacts on strategy as it enables a previous desire for reform, or it catalyses discussion about reform. In one case study, ICT had a pivotal role in the redesign of the curriculum. In other cases, there is mention of pedagogical change as a driver at school level.

Whole school planning can improve with the help of ICT, as was demonstrated in four case studies. Ease of access for both schools and other administrative authorities, as well as ease of manipulation of data are factors that were mentioned. At least at school level, it appears that ICT can help lessen the administrative burden. Linked to this administrative advantage is the availability of pupils' work for assessment, e.g. through online portfolios which can also increase the involvement of parents.

COMMUNICATION AND COLLABORATION

There is clear evidence of ICT's impact on communication and collaboration at school level. There are two main aspects here: communication within the school and communication with the school's stakeholders. Special note should be taken of the positive impact that ICT seems to have had on communication with parents in several schools, and in particular of a few cases of schools in deprived areas where ICT seems to offer ways of involving those groups of parents that would normally only have quite weak links with the school. This impact on households can also be observed in the area of resources: there are instances where the school serves as an internet access point for the community, and also there are programmes where parents can obtain hardware or software at low cost through the school. At a time when information is seen as a key asset and access to information is regarded as almost a basic need, this form of school-community linkage is an important means of promoting equity.

These findings contribute to the formulation of the following recommendation:

> Recommendation 5. (Headteachers and teachers): Strengthen the pedagogical use of ICT and develop an open, knowledge sharing school culture.

ICT resources have also enabled greater flexibility, as was observed in three schools: with laptops for example, pupils and teachers are freer to roam, enabling them to work in groups, and accessing information as they go. This can improve the use of space, since almost any room can be turned into a learning space with the appropriate learning resources on hand. The advantage of having simulations available was also mentioned, as this can be a substitute for high-cost equipment (in physics for example) and also pupils can conduct experiments outside the classroom. It is quite clear that when - in contrast - desktops in computer suites are used, this can decrease flexibility, with rooms having to be booked, pupils having to move, and the dedicated computer space unusable for other purposes.

Two other interesting impacts of ICT were mentioned: ICT improves the image of the school and this can be seen as a marketing advantage; and linked to this, ICT helped one school attract good teachers.

These findings contribute to the formulation of the following recommendation:

> Recommendation 3. (Policy makers): Ensure effective and equal access to quality equipment and digital learning resources.

8. KEY FINDINGS AND AREAS FOR FURTHER INVESTIGATION

The findings and conclusions set out here are drawn from the five STEPS contributory papers covering the research in the literature review (60 studies), LearnInd data, a representative survey of teachers in the EU member states (over 18,000 teachers), a policy survey covering 30 countries, 250 good practices submitted to the school survey, and 25 case studies.

AREAS FOR FURTHER INVESTIGATION

We indicate after each section a set of issues that have emerged from this work - and which in our view should be considered as areas for potentially valuable further study, research, and networking activity.

8.1 IMPACT ON LEARNERS AND LEARNING

ICT IMPROVES CHILDREN'S KNOWLEDGE, SKILLS AND COMPETENCES

There is a broad consensus among primary teachers about the positive impact of ICT on learners and learning. Research shows that a range of skills and competencies are acquired by the use of ICT: digital, communication, language (first and second), social and cognitive skills. Teachers interviewed in the LearnInd survey note a positive impact on basic skill acquisition (reading, writing, calculation) through the use of ICT - and research echoes this finding. UK research shows that English, maths and science test scores improve with ICT; and a Hungarian study shows that ICT-rich constructivist learning environments improve learning outcomes; especially for disadvantaged children. Many case studies highlight how ICT helps children understand the subject they are studying and caters for individual needs, although schools find it hard to isolate ICT's contribution to test scores.

However, research suggests that there is a discrepancy between children's under-use of ICT at school and their more frequent and often more sophisticated use at home. Although a range of digital skills are acquired outside school informally, some basic computer skills are not.

ICT INCREASES MOTIVATION, CONFIDENCE AND ENGAGEMENT IN LEARNING

Some 87% of teachers say that pupils are more motivated and attentive with ICT - according to the LearnInd data. Much of the research suggests that ICT has a positive impact on student attendance, behaviour, motivation, attitudes and engagement, that guided, active and enquiry-based tasks with ICT are particularly motivating, and that technology enables finer differentiation and personalisation. A large-scale comparative study shows that pupils participate more actively in learning when ICT is used. Teachers in the school survey felt strongly that ICT is a means of overcoming low motivation, social diversity and

disengagement. In the case studies there are examples of schools using ICT to improve links between learning inside and outside school and involve parents. ICT also impacted on group processes and collaborative learning.

ASSESSMENT CAN BE MORE SOPHISTICATED AND INDIVIDUALISED

ICT-based assessment systems used in some case study schools give more sophisticated feedback to teachers, parents and pupils on their performance, e.g. through the analysis of test scores. Virtual learning environments enable the individual tracking of progress and help identify the next 'learning step', so enabling pupils themselves to detect errors and shortcomings. Achievement can be recorded in e-portfolios.

AREAS FOR FURTHER INVESTIGATION

- Longer-term study of the impact of ICT on improving learning achievement, also taking in account the effects of differing learning styles.
- How quality assurance and inspection regimes are developing to take full account of ICT developments.
- Subject-specific investigation of ICT impact and potential, especially in:
    - key priority subjects such as basic skills and MST;
    - subjects where resource development by individual teachers is difficult and/or costly.
- Almost all aspects of assessment: developing effective tools to measure ICT skills; enabling ICT deployment by students within the assessment process; e-assessment; etc.
- Development of indicators on successful use of ICT in relation to differing learning tasks and contexts.
- Understanding the feasibility, costs and benefits of personalised learning.

8.2 IMPACT ON TEACHERS AND TEACHING

MOST TEACHERS USE ICT AND ARE 'ICT-OPTIMISTIC'

Some 75% of primary teachers (and their pupils) use computers in class according to the LearnInd data: from around 90% in the Nordic countries to approximately 35% in Greece, Latvia and Hungary. Teachers find that ICT supports in equal measure a range of learning and teaching styles, whether didactic or constructivist, in passive activities (exercises, practice) and in more active learning (self-directed learning, collaborative work). The research shows that rich constructivist learning environments improve learning outcomes, especially for learners from disadvantaged areas. Teachers in some countries (United

Kingdom, Cyprus, the Netherlands, Portugal and Poland) are more optimistic about ICT than others (Sweden, France and Austria). Nevertheless, a significant minority (21%) consider that using computers in class does not in itself have significant learning benefits. There is little to no correlation between impact-optimism and levels of school equipment, sophistication of use, or even teacher skills. There is a cluster of countries with high skill levels and high expectations as to ICT impact: the United Kingdom, the Netherlands, Cyprus and Malta.

ICT IS PEDAGOGICALLY UNDER-USED

Despite the high levels of reported classroom use mentioned above, according to some studies teachers use ICT more for administration, organisation and planning. They also indicate that teachers are aware of the potential benefits of ICT for students, have a positive perception of ICT in terms of supporting active autonomous learning and creating authentic tasks, but lack the pedagogical vision to integrate ICT effectively in teaching. The research shows that ICT can promote new pedagogical approaches, but only if ICT is fully integrated into subject lessons. In the Nordic countries, teachers in primary schools more often regard ICT as supporting their pedagogy than teachers in secondary schools.

QUALITY TRAINING INCREASES TEACHERS' MOTIVATION AND DIGITAL AND PEDAGOGICAL SKILLS

Teachers responding to the good practice survey consider that using ICT improves their motivation and teaching skills. We know from the policy survey that the 30 countries are investing in developing teacher ICT skills; but that in a significant number of countries teachers entering the profession may have little formal training in using ICT in teaching. Researchers have drawn some worrying conclusions about the effectiveness of continuing professional development in ICT: that teachers have failed to acquire the desired level of ICT skills for classroom instruction and that training has not translated into gains in pupil learning. Research suggests that teachers adapt more easily to new technologies through a step-by-step approach with minimal disruption, and that on-site is preferable to off-site training. Training courses failed to match needs and lack the pedagogical and practical dimension, according to the analysis of responses to the policy survey. The survey also indicates that reliable technical back-up and inspiring pedagogical support for teachers are often missing.

AREAS FOR FURTHER INVESTIGATION

- Pinpointing sound pedagogy and understanding whether and in what ways ICT specifically can enhance teaching and learning.
- Developing fully integrated models of ICT-supported learning delivery which provide examples and templates to guide local development.
- The environment and conditions for continuing professional development for teachers in relation to ICT.

- Improving inter-operability in the interests of maximum exchange, deployment, and sharing of teaching materials.

8.3 IMPACT ON SCHOOLS AND ICT PLANNING

CHILDREN'S ACCESS TO TECHNOLOGY IS IMPROVING

Analysis of the 2006 LearnInd data reveals that almost all primary schools use computers, with at least 88% of schools in each country having internet access and with an average of eight internet computers per 100 pupils. However, there are huge variations in ICT infrastructure and connectivity across and within countries. The computer-to-pupil ratio ranges from Luxembourg (23 computers per 100 pupils), Denmark and Norway (18), the United Kingdom (16), and the Netherlands (15) to much lower figures for Latvia, Lithuania and Poland (6) and Greece and Slovakia (5).

According to figures provided for the policy report, the computer-to-pupil ratio ranges from 3.1 (Greece) to 32 (Luxembourg) per 100 pupils and eight countries have more than 14 computers per 100 pupils (representing over 50,000 schools). 74 percent of primary schools in responding countries have a broadband connection to the internet, and in 21 countries over two-thirds of primary schools have broadband. Interactive whiteboard provision ranges from very few (e.g. Finland, Norway) to near saturation (the UK, where all primary schools have at least one). Denmark, Estonia and Norway have the highest levels of virtual learning environments that offer access from outside school. Smaller primary schools are disadvantaged in terms of equipment according to research, yet case studies show that the benefits for schools in small communities are considerable.

WHOLE SCHOOL ICT INTEGRATION AND LEADERSHIP MATTER

ICT integration in subjects and classrooms is the key to changing teaching practices, according to research - and the school leader´s support is crucial in cases where primary schools are free to integrate ICT in the curriculum. The policy survey suggests that countries with high levels of ICT favour dispersion into classrooms. Some 68% of primary schools have computers in classrooms, rather than in computer labs, according to the LearnInd data. This is the case in more than 90% of primary schools in Luxembourg, Slovenia, the United Kingdom, the Netherlands, Cyprus and Ireland. In contrast, there are ten countries with computers in classrooms in fewer than 50% of schools (Cyprus, Estonia, Greece, Italy, Latvia, Lithuania, Hungary, Poland, Slovakia and Spain). In these countries, the majority of primary schools use computers for education in dedicated computer labs.

ICT IMPROVES ADMINISTRATION AND ACCESS TO INFORMATION

Schools have incorporated ICT into management tasks and ICT is increasingly used by teachers for administration and planning. In several case studies, school-wide planning improved with the help of ICT. This because ICT makes administration accessible to wider groups through a web interface; school records are more easily maintained, exchanged and updated. However, research indicates that school ICT plans tend to concentrate more on

infrastructure than on how ICT can be used to enhance teaching and learning, and this can actually work against innovation (as found in some case studies). Virtual learning environments are becoming more widespread, but are used more for administration than for learning. Research shows that sufficient time is needed to assimilate virtual learning environments. However, once introduced, they are increasingly used by teachers.

AREAS FOR FURTHER INVESTIGATION

- The economics of ICT investment, at both micro (e.g. optimal initial capital and human resource investment at school level) and macro (e.g. the relative effectiveness of local, regional, and national investment) levels.
- Exchange of best practices in reaching remote and disadvantaged communities.
- How ICT in school management can support and facilitate the teacher's role and the quality of the educational experience.
- Models for managing and supporting ICT development and use at school level.

8.4 SYSTEM

STRATEGIES FOR ICT TEND TO FEATURE INFRASTRUCTURE AND TEACHERS' DIGITAL COMPETENCE

Responses to the policy survey indicate that all 30 countries have or have recently had at least one ICT policy or initiative affecting primary schools, usually aimed at improving infrastructure and digital competence among teachers; and less frequently targeted at the supply of digital learning resources, pedagogical reform or leadership. From the 74 policies, programmes and projects analysed in the study, strategies range from a system-wide intervention including ICT to specific projects focused on, for example, equipment, e-safety, or teacher educator ICT training - and with the locus of control running from central government control to high levels of school autonomy and responsibility. ICT in schools is still a topic that arouses controversy; and where the debate involves the general public, the concerns tend to be about e-safety, according to the policy surveys.

DIGITAL COMPETENCE USUALLY FEATURES IN THE CURRICULUM

Digital competence is in the primary school curriculum in 22 of the 30 countries according to the policy survey, either integrated across subjects (in 15 countries) or taught as a separate subject (in 11 countries). LearnInd data shows that teaching ICT as a separate subject, computer science, varies across Europe: ranging from being taught in nearly all schools in Latvia, Poland and Hungary to very few in Finland (19%) and Austria (9%). There is little evidence from the LearnInd data to suggest that teaching computer science as a separate subject implies placing less importance on ICT in other subjects. There are, however, exceptions to this observation: in the United Kingdom, ICT is used in most subjects in 94% of schools; but at the same time, computer science is taught separately in only 52% of schools.

In Latvia, conversely, ICT is used in most subjects in 42% of schools and computer science is taught separately in 97%.

ICT RESPONSIBILITIES WITHIN THE SYSTEM CAN BE UNCLEAR

In most countries ICT is part of general education policy and there is also a specific ICT policy for all schools, but no specific policy for ICT in primary schools. In countries where ICT has long been used in primary schools, policies seem to make fewer explicit references to ICT; and so ICT could be said to be pervasive and a given. Responsibilities can be unclear according to the policy survey: while primary schools have increasing autonomy as public sector services become decentralised, ICT responsibility in the system varies and is sometimes unclear. Hardware provision is often a national or municipal responsibility, but not maintenance, technical or pedagogical support. This can leave schools in some confusion.

AREAS FOR FURTHER INVESTIGATION

- Understanding ways in which national and regional strategies can address the aim of improving the quality of education.
- Whether there are differential impacts depending on whether ICT skills are taught separately or through integration in the general curriculum.
- Creating a flow of information on future visions for ICT in education (e.g. emerging new technologies; integration; networking; mix of school-based and home-based learning).
- Rates of investment in ICT in education: how have they developed in recent years, what are the current trends, and is investment sustainable?

9. RECOMMENDATIONS

The following recommendations are drawn from the evidence and findings gathered together in the five analytical papers of the STEPS study. These reports identify how ICT has impacted in primary schools and point to problem areas where action is needed. The recommendations, discussed with stakeholders during a workshop in June 2009, target three different education communities:

- Education policy makers (national, regional and local);
- Schools (head teachers and teachers);
- Research community.

Each recommendation is stated as a headline encapsulating its main focus. An introductory paragraph outlines the underlying evidence behind it, followed by a number of specific action points.

9.1 RECOMMENDATIONS TO EDUCATION POLICY MAKERS

RECOMMENDATION 1. IMPROVE, DIVERSIFY AND CERTIFY ICT TEACHER EDUCATION AND SUPPORT HEAD TEACHERS AS LEADERS OF CHANGE

As the evidence from the research and the policy maker survey shows, the professional development of teachers in ICT – initial as well as continuous professional development – although high on the policy agenda for several years, has failed to match teachers' needs and has lacked the pedagogical and practical dimension which would improve teaching and benefit pupils' learning. Teachers use ICT to achieve general education goals, are ICT optimists, but are resistant to abrupt change. Moreover, teachers' digital competence (pedagogical and technical) is not officially certified in many countries, despite the fact that ICT has emerged as an important professional development tool for teachers.

Furthermore, the research shows that the vision and commitment of the head teacher contributes significantly to the successful integration of ICT throughout the curriculum. However, there is little reference in national studies to specific training programmes for school leaders and their effectiveness.

We therefore recommend that national and regional policy makers and advisors:

- Ensure training (provided by credible trainers) addresses the pedagogical and practical dimension, is related to subject-specific didactics, and is personalised (incremental, on-site, tutor-based, with peer sharing of experiences).
- Certificate teachers' ICT skills to boost impact and reward significant investments already made by many teachers. Demonstrate that digital skills are a priority.

- Highlight models of carefully selected effective and transferable practice to inspire change in the teaching workforce, a way of inspiring change in the teaching workforce.

- Build up the capabilities of school leaders to manage ICT and ICT-related educational change, supporting them at national, regional and local level in their decision-making through guidelines, self-review frameworks and peer learning, linked to a set of common indicators of ICT quality in teaching and learning in the school.

RECOMMENDATION 2. BUILD ICT INTO GENERAL EDUCATIONAL POLICIES, INCLUDING ASSESSMENT

ICT can act as an enabler for developing 21st century skills, creativity and lifelong learning, for social inclusion, personalisation and to meet special educational needs, increasing children's appetite for school according to research. Above all, young children are motivated and largely self-skilled to use new technologies.

ICT is also a proven means to involve parents, and a catalyst for modernising planning and assessment procedures, releasing teachers' time for quality teaching. Moreover, as the quantitative analysis shows, conditions are right to move forward: primary schools are more or less equipped and connected, teachers are positive about ICT. On the other hand, as the school survey indicates, schools have low levels of awareness of ICT strategies apart from those that fund, support and provide resources. Comprehensive and educational visions which embrace ICT are either missing or not well communicated. The absence or discontinuity of ICT policies in a politically unstable environment is clearly a barrier for schools, teachers and learners as shown by responses to the policy and school survey. The use of ICT in assessment is not yet widespread in many countries, even though benefits are emerging as seen in case studies in new forms of feedback on learning, skills acquisition, progress tracking, testing and certification that use ICT.

Therefore our recommendation is to build ICT into general educational policies, including assessment. In particular we suggest to policy makers:

- Give policy signals that ICT can enable wider educational and economic objectives, and that ICT should be systemically embedded and mainstreamed.

- Make national strategies clear, coherent, enabling and structured. They should outline ways of implementation, be operational and not overly prescriptive. Specify clearly the ICT responsibilities of local authorities.

- Integrate ICT explicitly into the curriculum, a curriculum which is flexible, open and gives room for school-level initiative. Define the specific ICT functional skills and a set of skills and competencies developed with ICT. Aim for a culture of 'ICT everywhere, learning everywhere'.

- Investigate all aspects of assessment; develop effective tools to measure ICT skills, allowing ICT use by learners in tests, and ways to assess new skills and competencies.

RECOMMENDATION 3. ENSURE EFFECTIVE AND EQUAL ACCESS TO QUALITY EQUIPMENT AND DIGITAL LEARNING RESOURCES

Lack of computers is stated most frequently as a barrier for ICT use by teachers, who do not use computers in class according to the quantitative survey. The evidence from the case studies and research indicates that small primary schools can be disadvantaged in terms of equipment. Case studies also show that ICT resources in primary schools can enable greater flexibility for students to access information and enabling group work. Attractive multimedia resources and game-based activities play an important motivational role for primary school children and they are considered by policy-makers as highly important.

Therefore we recommend that policy-makers:

- Ensure equitable access to ICT equipment and resources, especially in small primary schools, by moving away from funding based solely on the number of students per school.
- Cluster remote and small schools to reduce isolation. Engage in the exchange of best practices in reaching disadvantaged schools.
- Support initiatives to improve the interoperability and sharing of high quality teaching and learning resources and practices in the interests of maximum exchange and deployment.

9.2 RECOMMENDATIONS TO SCHOOLS (HEAD TEACHERS AND TEACHERS)

RECOMMENDATION 4. CAPITALISE ON CHILDREN'S ICT COMPETENCE AND REDUCE DIGITAL DIVIDES

There is a discrepancy between home and school use of ICT by learners as revealed in research. Home use tends to be more technologically advanced, personal, self-directed, informal, playful, unstructured and experimental. Although a wide range of digital skills are acquired outside school informally, some skills are not.

Therefore schools should:

- Capitalise on learners' ICT skills in a variety of motivating ways for learning, by providing compelling ICT based learning opportunities at school and as extra-curricular activities, thus ensuring those who are ICT disadvantaged at home in terms of access or supervision are not further disadvantaged in school.

- Offer authentic and enquiry based learning tasks involving the learner more actively (including play), and use ICT for self-and peer assessment.
- Use the potential of ICT to support traditional and basic skills but also '21st century' skills and competencies such as learning to learn or critical thinking.

RECOMMENDATION 5. STRENGTHEN THE PEDAGOGICAL USE OF ICT AND DEVELOP AN OPEN, KNOWLEDGE SHARING SCHOOL CULTURE

As the findings from research and the school survey show, ICT increases motivation, confidence and engagement in learning. These are likewise the factors that positively influence the learning process and learning outcomes. The findings also show that teachers lack the pedagogical vision to integrate ICT effectively in the teaching and learning processes. Training programmes have failed in many countries to meet the practical and pedagogical dimension of ICT implementation in schools. When ICT usage is based on sound pedagogy, teachers are convinced of its value and teaching is more interactive according to research.

We therefore suggest to school leaders and teachers to strengthen the pedagogical use of ICT by developing an open knowledge sharing school culture. In particular:

- Use ICT to support autonomous or self-directed learning of students, but where the teacher still stimulates, explains and supports the student. Prefer promoted independence models to models where learning is strongly controlled by the teacher or conversely where learning is organised by the pupils themselves.
- Integrate ICT fully into subject teaching but also use it as an interdisciplinary approach in collaborative projects. Physically locate computers in classrooms and teachers' rooms to improve integration into subject teaching and to foster the exchange of practices.
- Engage with peers in the exchange of practices and resources (in subject- and topic-related working groups within and with other schools) using ICT as a driver to upgrade teachers' professional competencies.
- Aim for openness and education partnerships, creating more fluid boundaries between partners in learning (school, libraries, parents and the community) during and beyond the formal school day. Use a virtual learning environment which brings together learners, teachers, management and families, resources, administration and assessment.

RECOMMENDATION 6. EXPLOIT THE POTENTIAL OF ICT AS A CATALYST FOR CHANGE AND TO FULFIL EDUCATIONAL GOALS

ICT can act as a catalyst in many areas, a driver for change, modernising planning and administration, motivating lifelong learning for teachers and students, increased student motivation and attendance. Teachers are overall ICT optimists and use ICT as tool for

planning and lesson preparation according to the quantitative survey. The head teacher plays a crucial role (as enthusiastic teachers likewise) in releasing this potential impact of ICT.

We therefore specifically recommend to school leaders to:

- Embed ICT into the educational vision of the school clearly showing where it can make a difference and act as a tool for change, and emphasising the positive impact of ICT to achieve a wide range of educational goals.
- Give incentives for teachers to use ICT and reward its use.
- Develop the use of technology for management, communication, administration, planning and preparation as a starting point for wider systemic change.
- Specify clearly roles and responsibilities for ICT and pedagogical support.

9.3 RECOMMENDATIONS FOR RESEARCH

RECOMMENDATION 7. APPLY A VARIETY OF METHODS TO MEASURE AND ASSESS THE IMPACT OF ICT

Most studies on the impact of ICT reviewed in STEPS are qualitative and national and ICT impact assessment is mainly based on the perception of teachers. Evidence for improved test scores is only just beginning to emerge, let alone evidence for the impact of ICT on new skills (learning to learn, ability to create, innovate or collaborate), not widely assessed in today's education systems. The studies reviewed generally assess ICT's impact on national educational frameworks and goals.

While this yields valuable insights, we suggest to the research community to:

- Combine qualitative and quantitative methodologies in ICT impact studies to strengthen the current evidence base.
- Conduct large scale quantitative international comparative studies of primary pupils´ learning with ICT.
- Carry out longer-term studies on the impact of ICT on improving learning achievement, taking into account the effects of differing learning styles.
- Apply a range of methods to capture the effect of technology on learning, including test beds, ethnographic studies and learning from learners themselves to obtain insights into online behaviour and learning styles in different learning environments.

RECOMMENDATION 8. SHIFT THE FOCUS OF RESEARCH TOWARDS THE LEARNER AND THE SCHOOL AS A LEARNING ORGANISATION

National research mainly focuses on teachers and enabling or input conditions in schools that support learning with ICT (resources, curricula, leadership, and pedagogies). There is very little knowledge about the complex relationship between ICT use and 'third-order' impacts: on learning outcomes and test scores, the e-mature school and fruitful collaboration within and between schools which can have an impact on the schools, teachers and learners. There is hardly any evidence on evaluating school collaboration on a wider scale arising from the research, however, case studies indicate that ICT impacts on communication and collaboration at school level.

The following actions are therefore suggested:

- Direct research towards the scientific evaluation of the use of ICT, its benefits and impact on outcomes, in line with the high levels of investment in infrastructure and training.
- Evaluate the impact of ICT on schools, including school collaboration, interdisciplinary and innovative use of ICT within projects and the school as a learning organisation.
- Investigate subject-specific ICT impact especially in key priority subjects such as basic skills and mathematics, science and technology and in subjects where the development of teaching materials by individual teachers is difficult and/or costly.
- Explore and research how quality assurance and inspection regimes are developing to take full account of ICT developments.

RECOMMENDATION 9. ESTABLISH A LONG TERM AND CONTINUOUS MONITORING SYSTEM ON THE EFFECTS AND IMPACT OF ICT IN SCHOOLS

STEPS has examined one sector of education in isolation by applying an integrated approach drawing evidence from a variety of quantitative and qualitative sources. The literature review uncovered an absence of common indicators in relation to school levels of ICT readiness or e-maturity. There is a need for more systematic and rigorous measurement and data collection.

Further action to consolidate and extend this work could be considered by the national and European research community:

- Sustain and extend the existing knowledge base of ICT in primary education through further network activity, adding new studies and monitoring results over time regarding ICT in primary schools.
- Modify and apply the experience gained in the STEPS study to secondary and vocational schools (also tertiary and adult education). An evidence-based approach would shed more light on the impact of ICT in three main areas - teachers, learners and institutions - and identify the main enablers and barriers for ICT use.

- Develop a toolkit for indicator use by researchers, schools and policy makers. This includes achieving greater consistency across countries on definitions (e.g. broadband, a computer, e-maturity) and data collection by developing a continuous dashboard on progress on ICT use and impact on schools in Europe.

10. CONCLUDING REMARKS

There is certainly no simple answer about which strategy achieves the best results in terms of impact of ICT on learners, teachers and schools. With over 202,000 primary schools, ages ranging from 4 to 13, and the difficulty of making a simple link between cause and effect, we could even talk about a 'chaotic system'. The break-even point for effective integration and benefits at various levels for learners, teachers and schools differs throughout Europe. Evidence in some countries suggests a more advanced and integrated roadmap towards change; other countries are in the course of catching up and are struggling towards coherent policy and resources.

The boundaries between learning and other activities are becoming more fluid, with ubiquitous learning becoming everyday practice - whether at home, at school or with friends – and ICT is revealing itself as an important driver for lifelong learning for learners. Schools are an important place to balance inequalities in terms of access and knowledge about ICT. Primary schools especially have an important role to play in teaching digital literacy and other skills relevant for this age group (for example, internet safety issues). ICT has likewise emerged as an important professional development tool for teachers; and therefore also contributes to lifelong learning for this professional group, as indeed it does for any other profession that needs to be up-to-date in today's knowledge society.

Overall, the evidence shows that ICT is used as a tool to achieve a wide range of educational objectives:

- More differentiated and personalised learning
- Integration of minority groups
- Innovation in teaching
- Modernisation of planning and assessment procedures
- Transforming and enhancing communication, e.g. serving remote schools; bringing parents and teachers closer
- Development of key competences.

ICT is therefore a key enabler for initiating change in our education systems, releasing creativity and innovation and motivating lifelong learning.

In the 30 countries in this study significant investments have been made to fund infrastructure and training, but less on the scientific evaluation of the use of ICT and its benefits and impact. This imbalance between securing the inputs and evaluating the outputs could endanger the further investments in ICT that are needed to maintain the drive and bring to fruition long-term changes that take time to materialise.

ACKNOWLEDGEMENTS

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Design:	Dogstudio (Belgium)
Special thanks:	Petru Dumitru and Riina Vuorikari, respectively reporters for the Romanian case studies and the Finnish case studies

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Special thanks: Odile de Chalendar and Ferry de Rijcke, respectively reporters for the Danish case studies and the Slovenian case studies

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Eugenijus Kurilovas	Lithuania	Centre of Information Technology for Education

Astrid Leeb	Austria	Education Highway, Innovationszentrum für Schule und Neue Technologie GmbH
Karl Lehner	Austria	Austrian Virtual School team
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Dennis Zammit	Malta	e-Learning Centre
Lawrence Zammit	Malta	Ministry of Education, Department of Technology in Education

Special thanks: Margarida Belchior with Cristina Azevedo Gomez, Fernando Jorge Lima, Cidália Marques, Cristina Novo, Maria do Rosário Rodrigues and Sónia Santos Alves; Andrea Kárpáti; Anna Klerfelt; Alessandra Missana and Marilena Nalesso; and Nathalie Terrades, respectively reporters for the Portuguese case studies; the Hungarian case study; the Swedish case study; the Italian case studies; and the French case

studies. Thanks also to Mick James for reporting on one of the UK case studies.

SCHOOLS AND TEACHERS

The STEPS team would also like to thank the staff and children of schools involved in the case studies for the warm welcome and fruitful collaboration developed during the visits:

Molleskolen, Ry, Denmark

Skovvangskolen, Allerød, Denmark

Sondervangsskolen, Hammel, Denmark

Harkujärve Lasteaed-Algkool, Harku, Estonia

Kiili Gümnaasium, Kiili, Estonia

Mäntymäen Koulu, Kauniainen, Finland

Turun Normaalikoulu, Turku, Finland

Ecole des Amandiers, Paris, France

Ecole Blaise Pascal, Poissy, France

Gárdonyi Circle of Multigrade Schools, Hungary

G. Pascoli, D.D. Genzano, I circolo, Rome, Italy

I.C. di Villa Santina and D.D. di Gemona del Friuli, Udine, Italy

De Triangel, Gouda, Netherlands

Rossio ao Sul do Tejo Primary School and Chainça Primary School (D. Miguel de Almeida School Cluster Group), Abrantes, Portugal

Foros do Trapo Primary School (Pegões, Canha and Sto Isidro School Cluster Group), Portugal

Gomes Eanes de Azurara School Cluster Group, Mangualde, Viseu, Portugal

Scoala No. 191, Bucharest, Romania

Scoala No. 1 Gagesti, Bolotesti, Romania

Osnovna sola Louis Adamič, Grosuplje, Slovenia

Trnovo Primary School, Ljubljana, Slovenia

CEIP San Felix, Candas, Asturias, Spain

Grevegårdsskolan, Gothenburg, Sweden

Horndean Infant School, Hampshire, United Kingdom

New Invention Junior School, Willenhall, United Kingdom

Prince Albert Junior and Infant School, Birmingham, United Kingdom

Special thanks also go to the 255 teachers who took part in the STEPS school survey of good practice.

Brussels, June 2009