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Functional ICT Instruction On the Net

School Directors' and Policy Makers' Guidelines

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Project Number: 2018-1-SE01-KA201-039098

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Introduction

While teachers have a responsibility for their professional development, it is incumbent on school leaders to give their staff the necessary resources in time and technical equipment for them to become proficient. Likewise it is necessary that political representatives at both local and national levels recognise that digitalisation of the educational system does not happen for free, nor immediately. Indeed, there are studies indicating that digitalisation of education may have no discernible effect at all on learning outcomes [1].

It is also important to understand that the use of digital tools or the learning of programming does not automatically lead to the development of computational thinking [2], the ability to think in an organised and critical manner. We note anecdotally that similar results have been claimed for studying Latin, or calculus, and there is no reason to assume that a few hours of trying out a programming language will have any particular effects on pupils' thought patterns.

An important point to recognise is that digital tools may improve educational outcomes, as well as simplify the teachers' administration, but that neither of these goals means education becomes cheaper. A digital classroom requires that the pupils have access to computers (tablets, smartphones). These have to be purchased, but also maintained, and this typically cannot be done by the regular teachers, requiring skills beyond those outlined above, as well as additional time. The level of attrition should also be considered. While a computer may have a technical lifetime of at least 5–7 years, a school is a harsh environment and Some schools have a BYOD (bring your own device) policy, expecting the pupils to use their personal digital devices during lessons, but this is problematic for several reasons:

Not all pupils will have devices sufficiently powerful for the tools they are expected to use.

Heterogeneity of equipment makes it less likely that the intended learning tool actually is available for all required platforms.

There are security issues involved with allowing external devices to access the internal network of the school [3].

Being able to buy hardware (as well as necessary commercial software) in bulk lowers prices. It is therefore recommended that individual schools not be responsible for the purchase of student hardware, but that this be handled at the regional or even national level in order to get the best prices. (We do not suggest making purchases on the EU level, as each country typically will require computers with different keyboards and user interface languages, which may preclude buying in.) At the same time, pupils still need books, pencils, etc, so these items have to remain in the budget

Another important point is not to increase the administrative burden of teachers. While computers enable the gathering of more statistics, even semi-automatically, this should not be taken as an excuse to collect more data of dubious utility. Rather the opportunity should be taken to make an overview and limit the amount of data collected.

As noted earlier, professional development does not begin and end with courses; skills learned have to be practiced and this takes time.

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Resources

[1] Hall, C., Lundin, M. and Sibbmark, K. 2019. A laptop for every child?. Technical Report #2019:26. IFAU.
[2] Wing, J.M. 2006. Computational Thinking. Communications of the ACM. 49, 3 (Mar. 2006), 33–35. DOI: https://doi.org/10.1145/1118178.1118215
[3] Sugliano, A.M. 2018. BYOD semplice e sicuro: un modello e una soluzione tecnologica. Atti Didamatica 2018 (Cesena, Apr. 2018).

1.1 Desirable Digital Competencies for Teaching Science

As noted above, multiple competencies are required for effective use of digital tools in teaching. Typically the TPACK (Technological Pedagogical Content Knowledge) model [1] is used to describe these competencies:

Obviously teachers have to have content knowledge about the subject they are teaching. They also need to have the pedagogical knowledge how to impart their content knowledge.

Finally they have to have the technological skills to use digital tools to teach. These technological skills in turn consist of multiple layers. We have chosen to use the structure defined by the International Computer Driving License [2] where the basic level consists of understanding how to handle a computer, connect it to networks, peripheral devices etc, being able to use simple office software and access online resources with a web browser, considering Internet security. The intermediate level comprises simple programming, presentation software and the use of computers for teaching. The advanced level consists of more advanced use of the software introduced earlier.

Resources

[1] Herring, M.C., Koehler, M.J. and Mishra, P. eds. 2016. Handbook of Technological Pedagogical Content Knowledge (TPACK) for Educators. Routledge.
[2] ECDL Foundation: 2019. http://ecdl.org/ Accessed: 2020-02-03.

1.2 Appropriate Tools for Professional Development

Apart from a plethora of textbooks there are a number of online tools for learning to use digital tools. Office software often contains tutorials that can be called upon at precisely the moment where one needs to learn a certain feature. Sometimes the application may even guess at what the user is attempting to do and suggest a specific course of action.

There are also numerous third-party tutorials, many of them free and available on YouTube. At the same time there are proprietary online courses that at the very least contain tests for assessment of understanding and may also offer human teacher support as needed.

1.3 Appropriate Tools for Teaching Science Using Digital Tools

The important part in selecting a digital teaching tool is the pedagogical dimension. Merely replacing a

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previous analog method (say, OH slides) with a digital version (presentation software) does not in itself there will be any pedagogical changes, and therefore not necessarily any changed learning outcomes. Thus, the tools to be used should allow a mode of learning that would otherwise be difficult to achieve, for example:

- Interactive animations and visualisations of processes or objects;
- self-directed studies by pupils;
- support for students with reading/writing disabilities.

We can further divide the types of tools as:

- Tools used by the teacher only. These are for example animations, demonstrations, and such.
- Tools that are shared by the class, and used under teacher supervision, e g Smartboards used in turns by pupils and teachers, or video conferencing software to communicate with people elsewhere.
- Tools used independently by the pupils. This may be the use of search engines, word processors, or interactive simulations, modelling software, or programming environments.

Tools that are used mostly unsupervised have the problem that while they are useful for learning, they are also a cause for distraction, or to be precise, the devices the tools run on—computers and mobile phones—run all kinds of other software that can be distracting even if the tool itself is not. Avoiding these distractions requires a level of self-discipline that pupils do not necessarily have, so may require closer supervision by the teacher.

2 Integration of ICT in Science Teaching: Existing Gaps

Introduction

This module provides guidelines for policy makers and school directors, based on the research findings on national policies. In the recent years there has been, at European level, an increase in the implementation of Information and Communication Technologies in Education, due to different strategies and policies implemented in several projects since the 80s. Developing scientific literacy and establishing a scientific awareness requires a new relation between teachers, learners and knowledge sources in order to find the most useful things for learning and the most effective ways ICT can help in this regard. The modern technology is considered a key role for continuing learning, since it ensures a fast access to every new knowledge around the world without spatial and temporal limits. Accordingly, ICT provides an increasing range of tools and a wide and varied set of contents which make this technology an important tool for people and societies to develop scientific and cultural abilities and be able to keep up with developed countries. However, in order to get the most advantages from ICT in developing the culture of citizens and increasing their abilities to produce scientific knowledge, educational institutions should observe the correct methodology of using ICT in learning processes through constructive learning strategies within social contexts to perform real tasks. It is necessary, in this context, to analyse, reflect on the current situation and produce guidelines pointing towards the improvement of teaching and learning with ICT. In

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particular, looking at the teaching of Sciences, where ICT tools can replace, in part, expensive laboratories.

2.1 Some Perspectives about the Current Use of ICT in Science Education

2.1.1 Introduction

Since trust, competence and accessibility have been considered critical components for the integration of technologies in institutions, it is necessary to provide teachers with ICT resources, including software and hardware, effective professional development, sufficient time, appropriate training and technical support. The problems can be classified into three levels: a) upper level, b) medium level and c) lower level, which are analysed below.

(a) Lack of software, lack of sufficient training, lack of learning equipment and computer problems were identified as high level problems.

Lack of software problems

This was one of the main factors that made the use of ICT difficult in many countries including Italy. Restrictions on access to hardware and software resources have influenced teachers' motivation to use ICT in the classroom. Not only, unreliable and pirated software, which is difficult to use, but also the sharing among several teachers has slowed down its use in school.

Lack of sufficient training

Most teachers do not have the ability to use ICT in the teaching-learning process because they have not received sufficient training opportunities. One of the three main problems for teachers' use of ICT in teaching is the lack of training.

The issue of training is certainly complex because it is important to consider different components to ensure the effectiveness of training. Indeed, training should not be limited simply to the use of ICT tools, but teachers should also be offered pedagogical training.

Lack of tools and resources for learning

Several research studies have identified the lack of an insufficient number of computers, peripherals and software copies and insufficient simultaneous access to the Internet as the main obstacles to the implementation of ICT in educational institutions. The accessibility of ICT resources does not guarantee the success of their implementation in teaching, not only because of the lack of ICT infrastructure, but also because of other problems such as the lack of high quality hardware, adequate educational software and access to ICT resources. Other authors also claim that a wrong choice of hardware and software and a lack of consideration of what is suitable for classroom teaching are problems that many teachers face. Most teachers also agree that insufficient ICT resources in the institution and insufficient time to review software prevent them from using ICT.

b) Reluctance to use new technologies, lack of motivation, lack of funding, delay in processing documents,

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lack of qualified technical staff were identified as medium level problems.

Teachers' reluctance to new technologies

One of the problems in the implementation of computers in teaching-learning is that of teachers", i.e. the problem of acceptance, which in turn has been influenced by their attitude towards these media. The attitudes of teachers have been considered to be the main predictors of the use of new technologies in education; the success of the use of new technologies in the classroom depends largely on teachers' attitudes towards these tools. Indeed, teachers' attitudes towards computers affect their use of computers in the classroom and the likelihood of benefiting from training. Much research has shown that teachers' reluctance to use new technologies is a significant problem. The application of new technologies in educational contexts requires change and each teacher is free to manage this change independently.

A key area of teachers' attitudes towards the use of technologies is their understanding of how these technologies will benefit their teaching and the learning of their students. Although teachers felt that the technology available was more than sufficient, they did not believe they were adequately supported, guided or rewarded in integrating technology into their teaching.

Lack of qualified personnel

Teachers who do not apply ICT in the classroom argue that "lack of knowledge and skills" is a binding factor.

Time limitation

Studies have shown that many teachers have computer skills in the classroom, but still make little use of technology because they do not have enough time. They need time to find information on the Internet, prepare lessons, explore and practice technology, deal with technical problems and receive appropriate training. The problem of lack of time exists for teachers in many aspects of their work, as it affects their ability to complete tasks.

c) Lack of confidence, lack of knowledge; course material and political influence were identified as low level problems.

Lack of trust

One of the problems preventing teachers from using ICT in their teaching is the lack of trust. The study investigated the reasons for teachers' lack of confidence in the use of ICT and found that, because of their 'fear of failure', many teachers do not consider themselves to be proficient in the use of ICT and feel anxious to use ICT in front of a class. Limitations in teachers' knowledge of ICT make them feel anxious to use ICT in the classroom and therefore have no confidence in using it in their teaching.

Lack of pedagogical skills

Another problem, which is directly related to teachers' trust, is the lack of pedagogical knowledge about the use of ICT in teaching practices.

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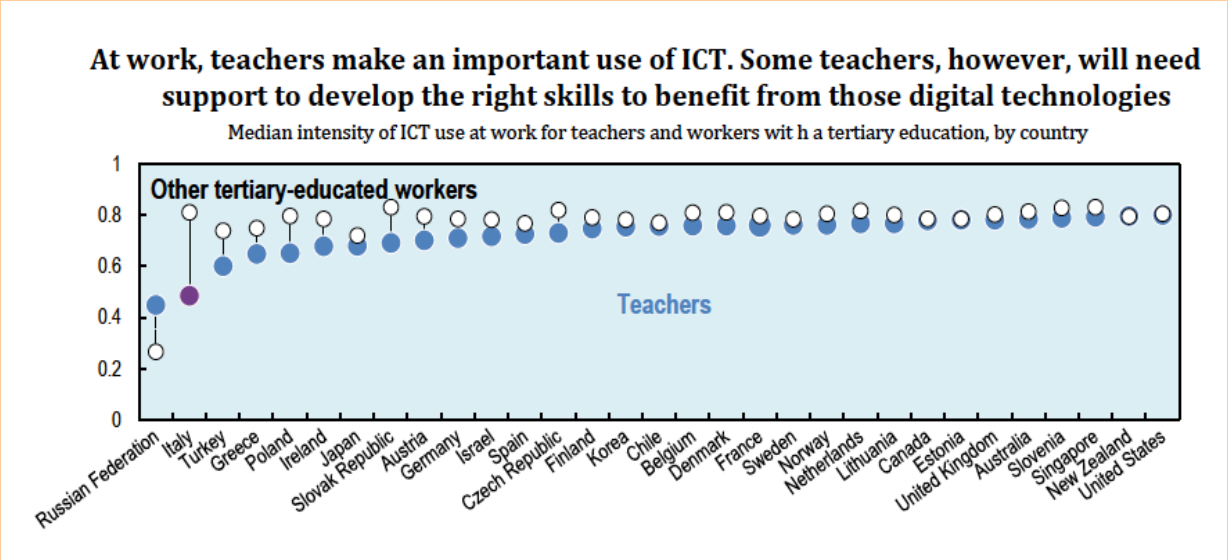

Source: Skills Outlook 2019: Thriving in a digital world. https://doi.org/10.1787/df80bc12-en

Constrictions on the use of ICT in educational institutions

It was found that there are many barriers related to administrators and the school's investment in hardware and software purchase and training.

Low-speed Internet, lack of IT skills, threat of viruses, lack of adequate training, lack of qualified staff, software problems, power problems, lack of motivation to encourage the use of ICT by the administration, lack of training, lack of adequate equipment and delays in the purchase of equipment are major causes that make it difficult to use ICT in the teaching-learning process.

Another important reason behind the teacher's failure to use modern technology for an effective teaching-learning process is dissatisfaction with the work. Their initiative, creativity, inventiveness have become lazy because of job satisfaction. Many teachers in institutions have remained in an unsatisfactory salary position because they have not received incentives due to wrong policies in educational institutions.

It was also found that the lack of adequate knowledge of the importance of ICT use also by administrators is one of the other factors limiting the use of ICT.

The implementation of a leading scientific literacy requires designing the appropriate learning environment through providing supplies, programs, networks, and the classrooms equipped with new technologies that enable communication with the world easily and quickly.

In summary, none of the problems highlighted above, if taken individually, is able to stimulate the improvement of the quality of teaching. The action to promote a breakthrough in the use of ICT, especially in scientific subjects, must see an integrated action at the level of education policy that addresses the shortcomings that most penalize and inevitably are different in each country and even within each nation.

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2.1.2 Sweden

In Sweden, the question of digital competence has been put in the spotlight due to the national strategy for the digitalisation of the K-12 school system launched by the Swedish Government in 2017, focusing on three areas: (1) digital competence for all in the school system, (2) equal access and use of digital technology and (3) research on and follow-up of the possibilities of digitalisation.

In the national strategy, children's and students' digital competence is discussed in terms of "adequate digital competence". It may therefore be reasonable to expect teachers' and school leaders' digital competence to be discussed in the same terms, although this is not the case in the strategy.

Several research on teachers' digital competence shows that there are still challenges related to (a) defining digital competence in educational policy and practice, (b) teachers' current levels of digital competence and the time and contexts and (c) the degree of readiness at an organisational level for the digitalised school.

In terms of equipment, students in Sweden are very well endowed compared to the EU mean. High-speed broadband provision too is at high levels throughout the system. Levels of connectedness (e.g. having a website or a virtual learning environment) are much higher than the EU mean.

Overall, There seems to be little use of innovative training modes (e.g. online communities) and of the pedagogical development.

2.1.3 Italy

In Italy, the National Digital School Plan (2015) was undoubtedly the first important moment of reflection about digital didactical practices at school in the institutional world. It represented the first moment of reflection on the educational processes, but also on the type of organization, school environment, spaces, teacher training and real connection between schools and the world of work. However, like all reforms, it has conflicted with an organisational and educational context, frequently not prepared to absorb and welcome the challenges, resulting in "a series of problems that clash, both with a very cumbersome and demanding organization of the ministry and, with the organization of schools" (policy-maker), impeding the widespread relapse of initiatives that remain occasional experiences, difficult to exploit.

In Italy, at the national level, there are still no clear guidelines and procedures that attend the education system to integrate digital innovations in educational processes and practices. In 2016, the Ministry created the School Single Data Portal for free access to data about schools, students, school staff, school buildings, national assessment system and national operational program (PON). In the same way, there is still no public monitoring and evaluation results regarding the efforts done.

A lot has certainly been produced in recent years in terms of investments, funding and attempts to systematise and improve the macro-processes that affect the school system, and this has given a positive impulse and an opportunity for the emergence and recognition of many experiences and skills spread in a leopard's eye. But there is still much to be done.

However, if it is true that Italy, as the OECD Report 'Skills Outlook 2019' also denounces, continues to present positions behind the OECD countries, it is also true that interest and participation are very high, testifying to the fact that the difficulty of integrating digital tools in the classroom cannot be banally reduced to 'reluctance' or low skills, but must be addressed in terms of the system. The teacher who is

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confronted with the potential offered by ICT is increasingly required to abandon the traditional habitus to acquire new professional tasks characterized by more complex skills of a design, management, evaluation, communicative, relational and empathic nature. However, in Italy this is a field in which the teacher is often alone and is trained in self-socialization paths played mostly outside formalized contexts.
While in many OECD countries teachers use ICT with the same intensity as other workers with tertiary education, Italian teachers lag behind and use new technologies well below other highly skilled workers. The data also show that 3 out of 4 teachers report that they need further training in ICT to carry out their profession.

2.1.4 Ireland

Ireland is currently developing its 2018-2022 ICT action plan to address skills shortages in this sector. OECD PISA survey results show that Irish 15- and 16 year-old students engaged significantly less often with ICT at school and with ICT use outside of school, highlighting the need for policy focus on this area (OECD, 2017).

A new computer science subject was being introduced in secondary schools from September 2018. Meanwhile, significant teacher supply and infrastructural deficits are set to be addressed.

In this context, there is a definite need for increased levels of initial and continuing professional development and support, where the focus is on constructivist pedagogical principles and on the use of ICT for teaching and learning within such learning environments.

Increased levels of technical support and greater emphasis on the development and evaluation of appropriate software are also necessary. As ICT skills continue to evolve and change it is important that IT in-service training focuses on the pedagogical skills needed to integrate the technology in teaching and learning rather than the technology itself.

2.1.5 Online Resources for European Policy

OECD (2018). PISA 2018 Results (Volume III): What School Life Means for Students' Lives.
https://www.oecd.org/pisa/
PISA is the OECD's Programme for International Student Assessment. PISA measures 15-year-olds' ability to use their reading, mathematics and science knowledge and skills to meet real-life challenges.

European Commission (2018). Digital Learning and ICT in Education.
https://ec.europa.eu/digital-single-market/en/policies/digital-learning-ict-education
This provides a summary of EC policies and supports for the use of ICT in Education and the embedding of digital learning in curricula.

European Commission (2019). Second Survey of Schools ICT in Education.
https://ec.europa.eu/digital-single-market/en/news/2nd-survey-schools-ict-education-0
The extensive summaries and breakdown of country responses and results are available

European Commission (2019). Second Survey of Schools ICT in Education Report of findings for Objective 2.

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https://ec.europa.eu/information_society/newsroom/image/document/2019-10/ictineducation_objective_2_report_final_4688F777-CDED-C240-613EE517B793385C_57736.pdf

A very extensive report on implementation of digitization in schools including Dimension 3 – CPD for teachers.

Co-funded by the Erasmus+ Programme of the European Union

Project Number: 2018-1-SE01-KA201-039098

3 Recommendations to Encourage Professional Development in the Integration of ICT in Science Teaching

Introduction

This module provides guidelines for policy makers and school directors, based on the research findings on national policies and programmes for Professional Development of teachers. The importance of digital competencies is *de facto* in current education systems. As members of the EC, Sweden, Italy and Ireland are presented with EU-wide policies informed by research into education and ICT access.

Appropriate tools for Personal and Professional Development have been identified but the policy makers and school directors have a major role in management of teachers' capability to participate in Continuous Personal Development (CPD) initiatives. These have been summarised in three categories:

External to the Schools

- National policies for Professional Development of teachers.
- Professional Development provided by education groups within each country.
- Support for Professional Development provided by national organisations.

Internal to the Schools

- Specific tools and technologies used across the school.
- Student management specific tools and technologies.
- General technologies available throughout the school.
- Teaching specific technologies.

Personal and Professional Networks and Instructional Design

- Mechanisms of collecting and curating appropriate resources.
- Rethinking pedagogies for the digital age.

Remedies/Recommendations

Remedies for teachers' and students' difficulties with uptake or implementation of ICT to supplement their teaching and learning can also be summarised under these headings:

- Infrastructure: access to high speed broadband.
- Access to hardware in classrooms.
- Access to software in classrooms.
- Embedding ICT training and implementation in Initial Teacher Education.
- Access to appropriate Continuous Professional Development training.
- Time for training.
- Whole school policies on ICT in education.
- Recognition of participation in Continuous Professional Development activities.

Of course, parents must also see the value in investing in hardware and software for their children's use in educational settings, e.g. smartphones and tablets. The students must also have access to high speed

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broadband if they are to complete self-directed homework tasks to complement their learning in school. All of this must be done with awareness of internet safety protocols.

The benchmark findings of the latest EU survey regarding ICT related teacher professional development are interesting:

- More than 6 out of 10 students across all ISCED levels are taught by teachers who engage in personal learning about ICT in their own time.
- Between 29% (ISCED 2) and 41% (ISCED 1) of students are taught by teachers who participate in online communities for professional discussions with other teachers.
- In contrast, only between 12% (ISCED 3) and 27% (ISCED 1) of European students are taught by teachers who participated in a compulsory ICT training.
- Between 43% (ISCED 1) and 50% (ISCED 3) of students are taught by teachers who have undertaken pedagogical courses on the use of ICT.
- Introductory courses on Internet use and general applications are more common among teachers than more advanced courses: between 27% (ISCED 2) and 31% (ISCED 2 and 3) of students are taught by teachers who undertook such introductory courses.
- Between 45% (ISCED 1) and 55% (ISCED 2) of students have teachers who invested more than 6 days in professional development in ICT during the past two years.
- Only between 2% (ISCED 1) and 4% (ISCED 2 and 3) of European students have teachers who report having spent no time at all on ICT related professional development activities over the past two years.
- At all ISCED levels, most applied methods by schools in order to reward teachers for ICT use in teaching and learning are providing additional training hours and additional ICT equipment for the classroom.
- Between 62% (ISCED 1) and 81% (ISCED 2) of students are in schools with an ICT coordinator.
- Both teachers and head teachers over all ISCED levels have a very positive attitude towards using ICT for learning and teaching. In this respect, the positive opinions of head teachers are even more pronounced.
- Both teachers and head teachers clearly agree that ICT use in teaching and learning is essential to prepare students to live and work in the 21st century.

The Teaching and Learning International Survey (TALIS) Report published in 2014 reinforces that CPD is key for teachers to integrate digital technologies into their teaching. While most teachers participate in at least some professional development over a year, in some countries as many as one in four do not do so at all. Over 20% of Italian teachers did not report taking part in professional development in the previous year. Most commonly, teachers take training in subject-specific topics, ICT skills for teaching, and knowledge of the curriculum. When asked to list their most important needs for professional development, teachers placed "ICT skills for teaching" (a particularly important need in Italy and Sweden) as joint highest. This was closely followed by 'new technologies in the workplace'. Interestingly, nearly 80% reported a moderate or large positive impact of professional development addressing ICT skills for teaching. In the opinion of teachers, the greatest barriers to engaging in professional development refer to conflicts with their work schedule, lack of incentives and the costs involved. The Republic of Ireland was not surveyed in this report.

Policy makers are advised that within the general EU framework they should encourage and support the

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exchange of best practices among countries and enable capacity building at national, regional and school level. The Second EC Survey on ICT in Education also summarises needs for CPD as Dimension 3 in building digital capacity. It references the CPD in line with the DigCompOrg Framework, which has been largely used for teachers' digital competence building for the effective use of digital technologies in teaching, learning and assessment practices, through rapid learning cycles, fast feedback, continual reflection, collaborative coaching and other methodologies.

A 2016 UNESCO study on ICT indicators in education that schools and education systems are not yet ready to leverage on the potential of technology, noting gaps in the digital skills of both teachers and students. That report showed that teachers and students have difficulties in locating high-quality digital learning resources, a lack of clarity on the learning goals, and insufficient pedagogical preparation for blending technology meaningfully into lessons and curricula.

Training for teachers in all areas of digital skills is a clear requirement for an effective adoption of digital technologies in classrooms. This also implies providing educators with professional learning opportunities on how to select and use (and, in the case of Open Educational Resources (OER), create and modify) digital instructional materials and integrate them into their classrooms. CPD should address both technical and pedagogical knowledge and skills, nurturing teachers' digital competence rather than teaching how to use technologies only. CPD should ideally be designed to meet teachers' individual needs as a priority, and it should also be incentivised in some way, e.g. designating time for such opportunities or offering concrete financial or other incentives for participation. There should also be a variety of formats to make the CPD relevant on an individual basis, e.g. Face-to-face training, Online training, Hybrid training, Leadership training.

3.1 Priority Areas: Policy Makers and School Directors role in CPD in ICT for Teachers

3.1.1 Sweden

Swedish schools have an extremely high share of highly digitally equipped and connected schools across all ISCED levels, with very high-speed connectivity widely available.
Recommendation: Continue to invest in new technologies and in upgrading infrastructure.
Schools with a strong policy and strong support have (among other features) existing school strategies in place to use digital technologies in teaching and learning and strongly promote teachers' professional development and in this category there is a slightly lower share in Sweden at ISCED levels 1 and 3 but higher share at ISCED level 2 compared to the European average.
Recommendation: encourage schools at all ISCED levels to develop string policies and support for teachers' professional development in accessing ICT training and implementation.
Digital competence is defined according to the DigComp framework and Swedish teachers show higher confidence at ISCED levels 1 and 2 in all digital competence areas compared to the European average. The DigComp framework assesses competence in five areas: Safety, Communication and Collaboration, Information and Data Literacy, Problem solving and Digital Content Creation.
Recommendation: continue to nurture the professional development of digital competence and ensure that

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it goes beyond ISCED 2.
Three types of Professional Development undertaken by Swedish teachers in the years 2017 – 18 show that at ISCED 1: results for Sweden comparable to European average. However, at ISCED 2: substantial differences to European average, much lower share of equipment-specific training and higher share of courses on pedagogical use in Sweden.

3.1.2 Italy

Highly digitally equipped and connected schools have (among other features) a high provision of digital equipment (laptops, computers, cameras, whiteboards) per number of students and a high broadband speed. In Italy, compared to the European average, there are slightly less highly digitally equipped and connected schools at ISCED level 2 and more highly digitally equipped and connected schools at ISCED levels 1 and 3.
Recommendation: While the ISCED level 3 schools score 86% in terms of being highly equipped there is room for greater provision at levels 1 and 2.
Schools with a strong policy, strong support have (among other features) existing school strategies in place to use digital technologies in teaching and learning and strongly promote teachers' professional development. In Italy at all ISCED levels there is higher than EU average policy and support.
Recommendation: Continue to encourage the high levels of support.
Digital competence is defined according to the DigComp framework, as detailed in the section on Sweden. There is slightly lower confidence of teachers in Italy at all ISCED levels in all digital competence areas compared to the European average.
Recommendation: Provide appropriate CPD at all levels to nurture digital competence in teachers.
Types of ICT related professional development courses undertaken by teachers in the years 2017-18 have been surveyed in three pillars as in Sweden. At all ISCED levels in Italy, there was a higher share of subject specific training on learning applications compared to the European average (except courses on the pedagogical use at ISCED level 2).
Recommendation: Continue to provide ICT related professional development courses to this standard.

3.1.3 Ireland

Much of the survey data for Ireland is only available for ISCED level 1 and that makes it difficult to assess how much support is needed at the higher levels.
Highly digitally equipped and connected schools have (among other features) a high provision of digital equipment (laptops, computers, cameras, whiteboards) per number of students and a high broadband speed. The share of highly digitally equipped and connected schools in Ireland at ISCED level 1 (the only level measured) is slightly lower compared to the European average. Only 33% of schools at ISCED level 1 are highly digitally equipped.
Recommendation: Policy makers need to find ways to increase the resources available to all schools.

ISCED level 1 schools were reported regarding school policy and support. Schools with a strong policy, strong support have (among other features) existing school strategies in place to use digital technologies in

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teaching and learning and strongly promote teachers' professional development. Strong policy, strong support: Lower share in Ireland at ISCED level 1 compared to the European average – only 7% of responses indicated strong policy and support. Weak policy, weak support: Lower share in Ireland at ISCED level 1 compared to the European average.
Recommendation: Guide school managers to develop policies and support systems to enable greater confidence.

Digital competence is defined according to the DigComp framework, as detailed previously. There was higher confidence of teachers in Ireland at ISCED level 1 in all digital competence areas compared to the European average.
Recommendation: This and the previous policy and support responses suggest that much of the competences are self-taught or through voluntary CPD. Perhaps encouragement of peer mentoring or more posts of responsibility for ICT competences could be a way forward.

Types of ICT related professional development courses undertaken by teachers in the years 2017-18 have been surveyed in three pillars as in Sweden. Lower share in Ireland at ISCED level 1 compared to the European average – except in courses on the pedagogical use of ICT in teaching and learning.
Recommendation: Increase equipment specific training – which may be linked to investing in more equipment for schools. Increase subject-specific training on learning applications.

3.1.4 Europe

Digital technologies are an inseparable part of today's learning process. The European Commission (EC) works on several policy initiatives in order to modernise education and training, provides funding for research and innovation in order to promote digital technologies used for learning and measures the progress on digitization of schools.
The EU member countries no doubt have their fingers on the pulse when it comes to policy, funding and implementation. The EC team responsible for this area is *Interactive Technologies, Digital for Culture & Education (Unit G.2).* The Unit's mission is to support the digital transformation of cultural and education institutions by: promoting the digitisation of cultural heritage and its wider access and reuse through new technologies and the further development of Europeana as the European cultural hub; fostering the modernisation of education and training systems in an age of rapid technological change; supporting policy, research, innovation and the wider take-up of interactive technologies, learning technologies and connectivity to allow European citizens to have a richer experience of cultural and educational content and to allow European business to create value from cultural content.
The Unit coordinates these Digital Service Infrastructures ("DSIs") under the Connecting Europe Facility Programme: Europeana, the e-Archiving building block and the future EU Student eCard. Among the initiatives relevant for Continuous Professional Development are:
The Action plan on Digital Learning: The European Commission has adopted on 17 January 2018 the Communication on the Digital Education Action Plan. The Action Plan outlines how the EU can help individuals, educational institutions and education systems to better adapt for life and work in an age of rapid digital change by: Making better use of digital technology for teaching and learning; Developing relevant digital competences and skills for the digital transformation; Improving education through better

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data analysis and foresight.

Improving and modernising education: In December 2016, the European Commission also adopted a Communication on improving and modernising education in order to provide a high-quality education for all, highlighting amongst others the benefits of digital technologies for offering new ways of learning.

Opening up education: In October 2013 EC published, a high-level European Agenda to seize the opportunities of the digital revolution in education and training, as well as the Communication on Rethinking Education adopted on 20 November 2012, investing in skills for better socio-economic outcomes.

Funding of Research and Innovation for Digital Learning: The European Commission funds many activities on research and innovation for digital learning under several programmes, including Horizon 2020, FP7 and CIP.

Calls for proposals that may encourage experienced practitioners to disseminate their experience and expertise as mentors to schools. *Mentoring Scheme for schools:* mainstreaming innovation by spreading the advanced ICT-based teaching practices to a wide circle of schools (€2 M) Date of publication: 05/11/2019, Date of closing: 12/03/2020

Measuring the progress on digitization of schools: In order to assess progress made in the introduction of ICT in education, the Commission has completed its plans to update "The Survey of Schools: ICT in Education". This first study was the last in-depth analysis on the uptake of technology in classrooms across Europe, with data collected in 2011-2012. It provided detailed and reliable benchmarking on the use of ICT in school education across Europe, from infrastructure provision to use, confidence and attitudes. In 2019 the results of an updated survey were published, addressing the need to provide more up-to-date figures to assess progress made in mainstreaming ICT in education and define the conditions for the future connected classroom.

The 2nd Survey of Schools: ICT in Education was carried out in 31 countries (EU28, Norway, Iceland and Turkey), by conducting interviews with head teachers, teachers, students and parents (ISCED level 1: primary schools: ISCED level 2: lower secondary schools; ISCED level 3: upper secondary schools). A range of different topics was covered, including: Access to and use of digital technologies, Digital activities and digital confidence of teachers and students, ICT related teacher professional development, Digital home environment of students, Schools' digital policies, strategies and opinions. The survey had two objectives:

Objective 1: Benchmark progress in ICT in schools - to provide detailed and up-to-date information related to access, use and attitudes towards the use of technology in education by surveying head teachers, teachers, students and parents covering the EU28, Norway, Iceland and Turkey;

Objective 2: Model for a 'highly equipped and connected classroom' - to define a conceptual model for a 'highly equipped and connected classroom' (HECC), presenting three scenarios to describe different levels of a HECC and to estimate the overall costs to equip and connect an average EU classroom with advanced components of the HECC model. The key findings of the survey are:

1. **Connectivity:** The European broadband targets foresee that by 2025 all schools have access to Gigabit Internet Connectivity. In fact, being connected to the Internet is a prerequisite for schools to, for example, access up-to-date resources or access online learning platforms. In addition, schools are increasingly requesting bandwidth-demanding applications such as video streaming or video conferencing. However, the results of the 2nd Survey of Schools: ICT in education show that **less than 1 out of 5 of European students attend schools which have access to high-speed Internet above 100 mbps**. In addition to that, large differences between and within European

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countries prevail whereas Nordic countries are clear frontrunners regarding the deployment of high-speed Internet in schools, other countries and schools located in villages/small cities clearly are lagging behind. The results of the survey, which show that the Gigabit connectivity goal is very much out of sight now, clearly back the future Connected Europe Facility Programme's aim to support access to Gigabit connectivity for socio-economic drivers including schools.

2. **Coding & related gender gap:** Digital skills including coding skills are essential so that everyone can take part in society and contribute to economic and social progress in the digital era. Coding helps practice 21st century skills such as problem solving or analytical thinking. The results of the 2nd Survey of Schools: ICT in education however show that students rarely regularly engage in coding/programming activities at European level. In fact, 79% of lower secondary school students and 76% of upper secondary school students never or almost never engage in coding or programming at school. Considering these figures, activities to strengthen students' coding skills at EU, Member States and local level need to be further scaled up. The goal of the European Commission is to encourage 50% of schools in Europe to participate in the EU Code Week by 2020, which is a grassroots movement promoting programming and computational thinking in a fun and engaging way. On average, more than 4 out of 5 female European students attending secondary schools never or almost never engage in coding school. These figures support the European Commissions' strategy to get more women interested in digital technologies by tackling three areas: the image of women in the media, digital skills for girls and women and increasing the number of female tech entrepreneurs.

3. **Teachers' training:** Continuous professional development is key for teachers to integrate digital technologies into their teaching practices. The results of the 2nd Survey of Schools show that more than 6 out of 10 European students are taught by teachers that engage in professional development activities about ICT in their own time. In contrast, participation in a compulsory ICT training is less common. In short, as teacher training in ICT is rarely compulsory, most teachers end up devoting their spare time to develop these skills. Member States must promote all forms of professional development, including incorporating digital skills in the curriculum of initial teacher training and in-service training of teachers. They should guide schools in incorporating the goals on digital technologies in school policies, strategies and overall vision. To facilitate teachers' professional development and further integration of ICT in education, Erasmus+ offers many successfully established tools for exchanging best practices, peer learning and professional development of teachers at EU level (e.g. through tools as eTwinning, School Education Gateway, Teacher Academy, SELFIE) – more common efforts will be needed to further scale-up and promote them among schools, teachers and policy-makers.

4. **Parents:** Most parents surveyed were in favour of the use of ICT in education, recognising its importance in the development of specific and transferable skills for future employment. The EC must continue to promote awareness of Safety in access to internet for all citizens but particularly children.

The second objective of the '2nd Survey of Schools: ICT in Education' aimed at designing a conceptual

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model for a 'highly equipped and connected classroom' (HECC), defining three scenarios of a HECC and estimating the costs to equip and connect an average EU classroom with advanced components of the HECC model.

- The entry level scenario outlines the minimum and essential components of a HECC.
- The advanced scenario further advances the entry level scenario, e.g. by entailing more advanced digital equipment, as well as a greater number of teachers' professional development activities and access to paid-for contents.
- The cutting-edge level is a further advanced scenario in relation to network requirements, it also includes a greater variety of digital equipment and increased opportunities for face-to-face professional development for teachers, and leadership training.

The survey results show that the average cost per student per year to equip and connect an average EU classroom with advanced components of the HECC model is in the range of 224-536 EUR. This cost range includes costs for digital technology equipment, network requirements, professional development of teachers and for access to content. Costs for setting up the physical infrastructure in terms of high-capacity networks is not included. The message from this result is that significant financial investment is required if the goals of digitization and ICT enhanced learning policies are to be reached.

Online Resources

Digital Learning and ICT in Education
https://ec.europa.eu/digital-single-market/en/policies/digital-learning-ict-education
[Accessed January 2020]
This provides a summary of EC policies and supports for the use of ICT in Education and the embedding of digital learning in curricula.

DigCompOrg
https://ec.europa.eu/jrc/en/digcomporg/framework
[Accessed January 2020]
DigCompOrg is designed to focus mainly on the teaching, learning, assessment and related learning support activities undertaken by a given educational organisation.

Second Survey of Schools ICT in Education (2019)
https://ec.europa.eu/digital-single-market/en/news/2nd-survey-schools-ict-education-0
[Accessed January 2020]
The extensive summaries and breakdown of country responses and results are available.

Second Survey of Schools ICT in Education Report of findings for Objective 2
https://ec.europa.eu/information_society/newsroom/image/document/2019-10/ictineducation_objective_2_report_final_4688F777-CDED-C240-613EE517B793385C_57736.pdf
[Accessed January 2020]
A very extensive report on implementation of digitization in schools including Dimension 3 – CPD for

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teachers.

Organisation for Economic Co-operation and Development (2014). TALIS 2013 results: An international perspective on teaching and learning. OECD.
https://www.oecd.org/education/school/talis-2013-results.htm
[Accessed January 2020]

J.M. Momino, & J. Carrere (2016) A Model for Obtaining ICT Indicators in Education (UNESCO)
https://unesdoc.unesco.org/ark:/48223/pf0000244268
[Accessed January 2020]

International Standard Classification of Education
http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-isced-2011-en.pdf
[Accessed January 2020]
ISCED 1 = Primary Education. ISCED 2 = Lower Secondary Education.
ISCED 3 = Upper Secondary Education. ISCED 4 = Post-secondary non-Tertiary Education.

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