Information and Communication Technology Policy in Primary and Secondary Education in Europe

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Abstract

The chapter draws attention to ICT policies in primary and secondary education in Europe. The authors explore a selection of policy initiatives and policy developments at regional and local levels considered to be significant for primary and secondary education in the region. Policy trends and early history of different national and European policy initiatives are highlighted, with a particular focus on the role of the European Union on the matter. The chapter addresses an increased differentiation between policies that: a) promote pedagogical use of ICT for improving subject-specific learning, b) promote fostering of learners' digital competence, and c) express initiatives related to the field of computer science. Cross-national and national examples provide a rich base of examples that showcase the variety of policy initiatives in the European region as well as recent trends and challenges with regard to educational ICT policies. The authors call for a stronger evidence-base in the field, and underline the need to utilise evidence to greater extent when designing pedagogical approaches, methods and tools involving ICT. The most pertinent challenges found are related to teachers' professional digital competence, changes in the world of work such as automation and the importance of lifelong learning and finally the increased emphasis on digital citizenship and digital responsibility.

Keywords

Digital competence · Professional Digital Competence · Digitalization · ICT · Europe · Primary and Secondary Education · Digital Citizenship

Introduction to ICT in Primary and Secondary Education in Europe

Europe is a diverse compilation of countries, regions, political unions, and partnerships. Theregion encompasses some of the world's most densely populated and some of the most desolated. Europe contains the world's largest trading bloc, the European Union (EU), and is also host to a wide range of bilateral and multilateral partnerships regulating economic, social, and political alliances between countries and regions.

The European region has been characterized by the term *variable geometry* (Delrio and Dondi 2008), which seeks to capture not only the area's diversity in culture, economy, politics, and demographics but also the somewhat fluid definitions through which countries or regions are included in the alliance. A United Nations list of European countries comprises 53 sovereign states, including Vatican City and the island of Sark. For the sake of consistency, this chapter will use the United Nations Statistic Division's list, as was used in a previous edition of this handbook. This list suggests that Europe is divided into four major regions based on environmental, cultural, and economic similarities. Eastern Europe consists of Belarus, Bulgaria, the Czech Republic, Hungary, Poland, Moldova, Romania, the Russian Federation,

Slovakia, and Ukraine. Western Europe consists of Austria, Belgium, France, Germany, Lichtenstein, Luxembourg, Monaco, the Netherlands, and Switzerland. Northern Europe includes the Åland Islands, the Channel Islands, Denmark, Estonia, the Faroe Islands, Finland, Guernsey, Iceland, Ireland, the Isle of Man, Jersey, Latvia, Lithuania, Norway, Northern Ireland, Sark, the Svalbard and Jan Mayen Islands, Sweden, and the United Kingdom. Finally, Southern Europe consists of Albania, Andorra, Bosnia and Herzegovina, Croatia, Gibraltar, Greece, Vatican City, Italy, Malta, Montenegro, Portugal, San Marino, Serbia, Slovenia, Spain, and Macedonia [Note 1].

Since each European country develops its education policies within a national context, content and structures vary widely. The aim of this chapter, *ICT Policy in Primary and Secondary Education in Europe*, is to provide an overview of ICT policies that illustrate some of the variety in the European region and the trends and challenges facing such policies as they relate to primary and secondary education. This chapter is not exhaustive and cannot cover the entire range and variety of policies in Europe. Instead, we will discuss a selection of policy initiatives and policy developments at the regional and local levels that we consider to be relevant and of interest to a wider audience both within and outside the region. In general, policies for economic, social, and political developments in European countries are increasingly geared toward recognizing the impact and importance of a digitized society, including for the educational sector. European countries were early to integrate information and communications technology (ICT) into primary and secondary education. Some countries developed policies for ICT in education throughout the 1990s, such as **Germany's** Schulen ans Netz [Note 2] and the **United Kingdom's** National Grid for Learning (BECTA 1998). Then, in the early 2000s, **Italy** released its Action Plan for the Information Technology Society (2001–2003), and **Finland** introduced its program for Education, Training, and Research in the Information Society, the National Strategy for 2000–2004 (Delrio and Dondi 2008).

The early phases of ICT integration in primary and secondary education often focused on teaching computing as a subject with limited additional curriculum integration. The early 1990s witnessed the advent of the multimedia computer as a possible learning resource within curricula (Plomp et al. 2009). With the introduction of the Internet, national governments began to develop policies for ICT as a tool for expanding learning in both content and topics (BECTA 1998). Then, in the mid- to late 1990s, several EU initiatives emerged for integrating ICT in primary and secondary education, representing an elevation of these priorities to the cross-national level. Lately, the use of ICT in primary and secondary education has been strongly connected to the general strengthening of knowledge, skills, and competences necessary for European citizens. Examples of this connection can be found, for instance, in the EU's definition of Key Competences for Lifelong Learning (European Parliament and Council 2006) and in the frameworks of the recent OECD PISA studies (OECD 2010a, 2013, 2016a).

In the following section, we will present some of the most recent and influential policy efforts at the EU level, look at current cross-national implementation strategies endorsed and implemented by European countries, and describe examples of extraordinary efforts at the country and local levels.

Recent Developments in ICT in the European Region

In this section, we will elaborate on recent developments and initiatives in different countries in the European region, focusing primarily on the topics of uptake of ICT in education, the concept of digitization in schools, and the use of ICT for student assessment.

Recent Findings on the Uptake of ICT in Education in European Countries

An important metric for the integration of computers into European schools has been the relationship between the number of students and availability of computers, aggregated at the national level. This metric is reported in, among other studies, the IEA studies SITES Module 1 (Pelgrum and Anderson 1999), SITES 2006 (Law et al. 2008), and ICILS 2013 (Fraillon et al. 2014), as well as in the OECD PISA studies from 2006 and onward (OECD 2006, 2010b, 2014a, 2016b). Though this metric is rough in the sense that it does not explore actual pedagogical usage in classrooms, it still provides an indicator of educational systems' capacities for investment and priorities concerning the integration of ICT in schools.

The latest PISA 2015 results (OECD 2016b) show that the median number of computers available per student aggregated at the country level is 0.66 for the 40 European educational systems participating in the study [Note 3], ranging from 0.14 in Kosovo to 1.49 in Iceland. Comparing countries, a median of 97.8% of computers are connected to the Internet, again with huge variations, ranging from 29.2% in Kosovo to 100% in Malta.

The results from IEA TIMSS 2015 [Note 4, 5] (Mullis et al. 2016) show that, of the 11 participating European countries [Note 6] that reported on the availability of computers for mathematics lessons in grade 8, the average coverage was 32% of students, ranging from 4% in Malta to 65% in Sweden. For grade 4, the average coverage among the 23 participating European countries [Note 7] was 40%, ranging from 13% in Serbia to 84% in Denmark.

Digitization of Schools and BYOD Initiatives

A wide range of parameters can be used to describe the uptake of ICT or, in a wider sense, the digitization of schools. According to a report from the European Schoolnet based on a survey of school IT administrators in Europe, countries vary widely with respect to their levels of digitization. The report states that six countries can be grouped together according to the extent of digitization:

- Highly digitized schools [Note 8] Denmark, Norway, and Sweden
- Digitally developing schools [Note 9] Poland, Romania, and Turkey

In addition, there are two Linux countries, Italy and Spain, with high levels of equipment and above-average Linux OS penetration (European Schoolnet 2015b, p. 24).

Educational authorities and school owners are increasingly supporting one-to-one learning environments for their students and teachers in primary and secondary schools. Due to considerable costs and maintenance demands, a growing interest in BYOD (bring your own device) or BYOT (bring your own technology) approaches rises. Such approaches to meet greater access needs also increase demands on teachers, who need to be ready to assist their students with a range of different digital tools (European Schoolnet 2015c). An example of BYOD implementation can be found in **Austria**, where two national initiatives are helping to drive eLearning, mobile learning, and BYOD (European Schoolnet 2015c).

The degree of digitization indicates an access divide, such that countries in Northern Europe seem to be better off in terms of equipment levels and policies supporting a diversity of technologies than Eastern and Southern European countries. However, this only indicates the potentials or opportunities teachers and students have to use ICT in school and does not reveal anything about the *extent* or *ways of use* of technology in schools.

Assessment and Digital Exams

Assessment practices influence and guide student learning in many ways. Efforts to digitalize matriculation exams are on the agenda in several European countries. Such interventions can have huge influences on digitalization and the overall implementation of ICT in schools. In **Finland**, the Finnish National Matriculation Examination Board is digitalizing the matriculation examination through the digitalization project DigiAbi (2016–2019) [Note 10]. This project will allow Finnish students to use the most common office applications, including multimodal text (including text, pictures, audio, and video), to respond to questions in the matriculation exam. Of all European countries, **Denmark** is likely the most advanced in terms of online exams in upper secondary schools. In 2013, Denmark adopted the Strategy for Digital Welfare, including an initiative for digital written tests in upper secondary education. The initiative also includes digital support for giving marks on academically relevant assignments and tests in primary and secondary schools (European Schoolnet 2015d).

Recent Developments on Policies on ICT in the European Region

Cross-national policies and, to a varying degree, national policies throughout Europe posit policy expectations that concern both the school and the education system as a whole. This is done in order to prepare students for further studies and their professional lives, which, to a great extent, will include the use of ICT (Balanskat and Gertsch 2010; Binkley et al. 2012).

A general observation on the development of policies for ICT in primary and secondary education in Europe is the move toward a more fine-grained understanding of different strands of applications of digital technologies. Initiatives concerning supporting ICT to improve subject-specific learning processes and general learning outcomes are increasingly being separated from initiatives supporting the fostering of digital competence. In this chapter, these two issues are treated under the heading "National-Level Policies" in the next section.

In addition, a separate strand of initiatives integrating "new" subjects or topics directly related to the field of computer science has also gained traction. These topics are labeled differently between countries but are commonly described in this chapter as the integration of ICT, technology, and coding within the curriculum. Recent developments see the use of the growing evidence base on ICT in schools, digital competence, and curricular operationalization as the foundation for evidence-informed policymaking at the national level (see section "Integration of ICT, Technology and Coding in the Curriculum").

National-Level Policies

At the national level, we see a range of initiatives being implemented or emerging based on specific national educational contexts. Here, we introduce a few examples showcasing a variety of different policy approaches and related actions.

A concrete example of how research evidence is being utilized to shape national educational policies can be found in **Germany**, where the division of responsibilities between the federal and the regional (Länder) levels creates a complex context for policymaking. Based on, among other findings, results from the IEA ICILS 2013 study (Fraillon et al. 2014), in which German students performed lower than anticipated on measured ICT competences, German policy makers at the federal level took action by citing the study in an official 2014 decision (Bundesministerium für Bildung und Forschung 2016). Official exchanges between policy makers and experts in the field have been arranged, and the recent release of the national strategy for Education in a Digital World (Bildung in der digitalen Welt 2016) laid the foundation for systematic capacity-building for the inclusion of digital competences in Länder's educational systems, including primary and secondary education, VET, and higher education. The Education in a Digital World strategy encompasses actions for digitalization within the fields of educational plans and curricular developments, CPD for educators and teachers, infrastructure, educational media and content, educational administration at all levels, and necessary actions within legal and functional frameworks. The strategy also promotes a strong focus on fostering digital competence as transversal competence for learning in all subjects.

Austria introduced a computer-based school-leaving exam in 2014/2015 and launched digital versions of schoolbooks in 2016. It has also initiated funding schemes for interactive whiteboards and mobile applications. Secondary school reforms aim to develop school policies that resonate with modern society, focusing on transversal key competences as their primary outcomes. Under the umbrella

agenda "eFit 21," the Ministry of Education has collected strategic aims, measures, and concrete projects. The main strategic objectives are to use ICT in schools to enhance the quality and efficiency of teaching and learning and to foster digital competences and social inclusion. An example of tangible output is the LMS (Learning Management Systems) project, which provides teachers learning modules for competence-oriented teaching (European Schoolnet 2015e). The www.digikomp.at initiative in Austria is also worth noticing as it provides a digital competence framework for learners and teachers in grades 1–12. It emphasizes the importance of digital competence in subject teaching but has not been integrated as a part of teacher education.

The 21 German-speaking or multilingual Cantons in **Switzerland** have published the curriculum "Lehrplan 21." It covers a new curriculum for all subjects including a new module called Media and Informatics "Medien und Informatik." It derives from the existing ICT module and defines competence in the areas of media education and informatics and is obligatory for all students. Lehrplan 21 structures topics along seven fields of action [Note 11], and these provide schools with guidance on the implementation of the curriculum. All Cantons have to develop competence framework and websites for schools and teachers with examples for lessons and projects and provide new textbooks on the issue.

In 2012, **Flemish Belgium** implemented a new policy plan for ICT and media literacy, putting forward a comprehensive action plan and implementation policies. The main goals are to support the development of a competence-based curriculum and frameworks, to increase spending on ICT infrastructure in schools, to fund open digital educational resources (including serious games, in-service teacher training on digital competences, and media literacy), and to boost research and innovation in the field. A specific outcome is a personalized digital platform for students in primary and secondary education for integrating data, knowledge, and information across all relevant school actors. This system will be incrementally developed to support capabilities in learning analytics (European Schoolnet 2015f).

The **Czech Republic** has devised a strategy for educational policies for the period from 2014 to 2020. The strategy has three main priorities: to reduce inequality in education, to support quality teacher training, and to support the responsible and efficient management of the educational system. The strategy links to ICT in primary and secondary schools through a general recognition of the importance of the role of digital technologies in teaching and learning. The initiative also includes a separate strategy for digital education, with a strong focus on modernizing the Czech educational system and enabling students to become lifelong learners in a digital society and a digitized labor market. The digital education strategy has three priority objectives for interventions: new digital teaching and learning methods, students' school-related digital competences, and the development of computational thinking. Concrete initiatives are operational programs focusing on the purchase of ICT equipment and teacher training in the field of ICT (European Schoolnet 2015g).

For the period 2011–2017, **Denmark** is pushing forward a comprehensive initiative for public schools addressing the structure of the school day, funding for teacher and headmaster training, and a nationwide system of learning consultants.

Boosting the use of ICT in public schools remains a high priority and is facilitated by a state initiative to develop a national market for digital learning resources by supporting 50% of school owners' purchases, providing funding to developers, and delivering an innovative quality framework. Capacity-building efforts involve building networks of digitally competent teachers, digital learning resource developers, and school principals involved in leading digital change. Beginning in 2013, the initiative has been followed-up with an extensive research program and a reform of teacher education (European Schoolnet 2015d).

An extensive strategy for lifelong learning between 2014 and 2020 guides efforts to modernize the educational system in **Estonia**. The strategy seeks to change the learning approach from teacher-led to student-driven and to accomplish personalization through the application of ICT. It also focuses on digitally competent school leadership and aligning lifelong learning opportunities with labor market needs. Estonia aims to foster digital skills and equal opportunities for learning in the long term. Responsibilities for fostering digital skills are shared between the state (e.g., through curricula, frameworks, and specific programs, such as digital learning resources) and school owners (e.g., through digital infrastructure, connectivity, and virtual learning environments) (Kerb 2015). A specific large-scale initiative at the school level is the 1:1 mobile learning initiative, which was organized according to a BYOD model. Together with university and business partners, Estonian authorities have also established the Information Technology Foundation for Education (HITSA) [Note 12], with a mission to "...ensure that the graduates at all levels of education have obtained digital skills necessary for the development of economy and society [and that] the possibilities offered by ICT are skilfully used in teaching and learning" (European Schoolnet 2015h, p. 6).

Integration of ICT, Technology, and Coding in the Curriculum

European education systems also take different approaches to relate to and integrate digital technology in their curricula and pedagogical use of ICT. This section explores countries that have introduced ICT as a separate subject taught either based on specific curriculum goals or as a general competence across disciplines. For instance, of the European countries participating in the ICILS 2013 study, ICT is a compulsory subject in secondary schools in the Czech Republic, Lithuania, Poland, Russia, and Slovenia and an optional subject in secondary schools in Germany and Slovenia (Fraillon et al. 2014). Based on a review of national instruction time, the Eurydice network monitors the national implementation of ICT and technology as separate subject domains in European countries (European Commission/EACEA/Eurydice 2016).

ICT is taught as an independent theme or subject in several EU member states. Some allocate a prescribed number of hours to the subject each year (Bosnia and Herzegovina, Bulgaria, Cyprus, Germany, Greece, Spain, Hungary, Lichtenstein, Latvia, Montenegro, FYROM/Macedonia, Malta, Portugal, Romania, Slovakia, and Turkey). Most countries in this group (except Greece, Slovakia, Spain, and Macedonia)

allocate time only at the secondary level. Overall, Greece dedicates the most hours to ICT at all grade levels, and Bulgaria dedicates the most hours to ICT in upper secondary classes. Denmark, the Netherlands, and the United Kingdom give schools and teachers the flexibility to allocate time across curriculum subjects as they see fit. A third group of countries incorporates ICT into instruction time for other subjects or as a flexible option (Switzerland, the Czech Republic, Denmark, Estonia, Ireland, Iceland, France, Lithuania, Austria, Poland, Serbia, Slovenia, and the United Kingdom), with varying degrees of implementation. Combinations of these three modes are also present in several countries (European Commission/EACEA/Eurydice 2016).

Technology is taught as an independent theme or subject in 19 member states (Bosnia and Herzegovina, Belgium [French-speaking and Flemish parts], Bulgaria, Cyprus, the Czech Republic, Germany, Estonia, Greece, Spain, France, Croatia, Hungary, Italy, Lithuania, Montenegro, the Netherlands, Poland, Portugal, Romania, Serbia, Slovenia, the United Kingdom, and Turkey). Of these, only three countries (Lithuania, the Netherlands, and the United Kingdom [Scotland and Northern Ireland]) offer technology education in upper secondary schools. Slovenia dedicates the most hours to technology, allocating a total of 319 h across grades 1–9. A variety of European countries also either integrate technology into other parts of the curriculum or offer a mix of the two modes of integration (European Commission/EACEA/Eurydice 2016).

Computer Programming, Computational Thinking, and Coding

As a part of the digital transformation in Europe and to strengthen students' competence, skills, and employability for the twenty-first-century job market, computer programming, computational thinking, and coding have been central to recent developments within European schools. Curriculum studies from European Schoolnet (2014, 2015a) show that among the European countries explored in the study, 15 (Austria, Bulgaria, the Czech Republic, Denmark, England, Estonia, France, Hungary, Ireland, Lithuania, Malta, Poland, Portugal, Slovakia, and Spain) include computer programming or coding as part of their national or local curricula, while Finland and the Flanders region of Belgium have plans to introduce these subjects. Countries offer multiple rationales for the integration of coding; however, the three most prominent involve this subject's ability to foster logical thinking skills, coding and programming skills, and problem-solving skills. Improving the ICT sector and increasing the number of students in computer science are also priorities for ten of the surveyed countries (European Schoolnet 2014, 2015a).

It is notable that the forthcoming IEA ICILS 2018 study includes a module for the direct assessment of computational thinking skills as an international option for participating countries [Note 13]. Though computational thinking is not directly analogous to programming or coding, the concepts are related. According to the IEA, computational thinking for working out how computers can help solve problems entails such processes as problem-solving, design, and relating basic concepts of computer science to human behavior. This signifies a breakthrough in terms of the objective assessment of this particular skill, and the results can also be used for national or cross-national educational policymaking.

Relevance of Cross-National and Worldwide Strategies and Plans for the European Region

For most European countries, the EU's systems for cooperation for educational development are the most important international frameworks for national policymaking. EU member states and other countries in Europe are included in both EU standardized statistical monitoring of educational systems (Eurostat 2016) and the EU-funded Erasmus + program for education, training, youth, and sport [Note 14]. The following section examines the common goals and frameworks put forward at the EU level.

Relevance of Cross-National Policies Under EU Frameworks

The EU has a long history in developing policies for including digital technologies in primary and secondary education. Current efforts in the field are closely tied to overarching cross-sectorial goals and strategic planning designed to tackle the combined ongoing effects of the financial crisis, youth unemployment, increased immigration, and the recent wave of terrorist attacks and threats. These efforts are also related to more proactive issues, such as the modernization of education, the fostering of skills in education that harmonize with labor market needs, and the wish for a civic intercultural dialogue across all layers of society (European Commission 2010, 2015a). In general, broad overarching policies for education at the EU level have usually been developed as cross-national intentional papers in the form of communications developed by the European Commission and debated and ratified by member states in the council. Given their abstract and intentional character, such overarching policy documents must be adapted and operationalized into more concrete measures, aims, and strategies that take local educational and political contexts into consideration.

Cross-national educational policies concerning ICT in education can be divided into (1) top-level cross-national policies targeting society at large, where education is one of many societal aspects addressed, and (2) operational policies specifically targeting the education and training sector. In the following sections, we will explore some specific examples of these two different modes of policymaking to better understand the dynamics in the discourse on educational developments and reform in Europe. The cases in question are the top-level cross-national policy goals of the EU 2020 strategy (European Commission 2010) and the Key Competences for Lifelong Learning framework (European Parliament and Council 2006). At the operational level, the ET 2020 cooperation framework (European Commission 2015a), the cross-ministerial European Schoolnet network, and the European Commission's newly developed framework for digital competence (Vuorikari et al. 2016), all geared toward improving the quality of national educational systems by increasing digitalization in education, will be used as examples.

Top-Level Cross-National Policies

Top-level cross-national policies tend to link rationales for educational developments to gains in other societal areas, mainly labor market outcomes. Such policies do not focus primarily on improving the educational system per se but rather seek to strengthen the output of education relevant to other sectors in society, including labor market outcomes, economic productivity gains through innovation and entrepreneurship, social cohesion through active citizenship and integration, and well-being perspectives.

The Europe 2020 Strategy (European Commission 2010) acknowledges that education and training play a strategic role in Europe's ability to remain competitive, overcome the current economic crisis, and grasp new opportunities. The digital transformation of education and training systems is, hence, a theme in several Europe 2020 flagship initiatives. Moreover, the European Commission's Opening Up Education initiative (European Commission 2015a) emphasizes the need for educational institutions to review their strategies in order to integrate digital technologies into teaching, learning, and organizational practices.

Recently, the New Skills Agenda for Europe (European Commission 2016) [Note 15] aims to align the skills available in the labor force with the actual skills demanded by the labor market. The Skills Agenda emphasizes that the digitization of society is an important backdrop for understanding the growing skills gap. As a consequence, digital transformation in society raises new demands for fostering skills inside the formal educational system, in adult learning and reskilling, and at the workplace. Thus, to increase the digital skills of European citizens, the Skills Agenda calls for specific actions mainstreaming and underlining the impact of digitization [Note 16]. To ensure that individuals are equipped with adequate digital skills, in this communication, the Commission stresses that digital skills and competences must be developed at all levels of education and training. Furthermore, it acknowledges that teachers and educators need to support best practices in bringing digital tools into the classroom. The Skills Agenda is also aligned with the educational sector through one of its main actions: the ongoing revision of the Key Competences for Lifelong Learning (European Parliament and Council 2006) [Note 17].

The Key Competences for Lifelong Learning were launched in 2006. They were originally devised as a framework for describing key competences across all sectors of society; however, evidence shows that the use of the framework in member states has been most pertinent in the educational sector (Gordon et al. 2009). The Key Competences framework originally defined the eight key competences as "...a combination of knowledge, skills and attitudes appropriate to the context. Key competences are those which all individuals need for personal fulfilment and development, social inclusion, active citizenship and employment" (European Parliament and Council 2006, p. 13). Furthermore, the framework defines digital competence as involving "the confident and critical use of information society technology (IST) and thus basic skills in information and communication technology (ICT)" (European Parliament and Council 2006, p. 15).

Operational Policies

An in-depth analysis based on PISA 2012 (OECD 2015) underlines that merely increasing access to digital technologies in schools does not yield higher learning outcomes, although specific and targeted use with clear pedagogical aims might do so. In pedagogical terms, digital technologies should ideally yield profound changes in learning contents and pedagogical practices and should lead to more immersive, connected, and natural learning processes. Digital technologies also hold the potential to increase institutional efficiency, data consistency, and interinstitutional connectedness (European Commission 2015b). At the cross-national level, there is limited mutual learning on best practices and/or failures in the process of integration and effective use of digital learning technologies, increasing the chances of cooperation opportunities being lost, work being duplicated, and mistakes or suboptimal implementations being repeated.

To address this situation, several cross-national mechanisms have been implemented. The current European Framework for Cooperation in Education and Training 2020 (European Commission 2015a) emphasizes the importance of developing transversal skills and key competences, particularly in the realm of digital competence. Specific actions include raising the skill levels of pupils and the workforce by improving the effectiveness of education and training systems. In line with this goal, the development of digital competence is a relevant priority area within the development of high-quality skills. Under the umbrella of the ET2020 cooperation framework, thematic working groups [Note 18] have been established, including a group on digital skills and competences, in which experts from national administrations in EU member states benefit from mutual discussion on the policy level and in situ peer learning activities on relevant issues.

The European Schoolnet (EUN) [Note 19] is, in itself, an example of and a mechanism for defining and implementing operational policies. The EUN is a network of 30 European Ministries of Education that aim to bring innovation to teaching and learning across schools, teachers, researchers, industry partners, and the ministries themselves.

Another good example of an operational policy developed in the EU is the Digital Competence Framework for Citizens (DigComp), first published in 2013 by the European Commission (Ferrari 2013) and updated in 2016 (Vuorikari et al. 2016). This framework is primarily a tool to develop policies that support digital competence building and to plan education and training initiatives to improve the digital competence of specific target groups.

Although the DigComp framework was designed to be of universal use for all sectors of society, the most prominent uptake has been within the educational sector. Successful examples of the use of DigComp as a backdrop for overarching school policies and a tool for revising instructional planning and designing self-assessment tools of digital competence for pupils can be found in several European countries. Examples of national and regional initiatives using DigComp for policy planning include the **Italian** National Plan for Digital School (Il Piano Nazionale Scuola Digitale) [Note 20] launched in late 2015; the **Maltese** "Green Paper: Digital

Literacy" [Note 21] launched in 2015; and the 2016/2017 work in **Navarra**, **Spain**, where DigComp is used for strategic planning in the regional Department of Education.

For instructional design purposes, prominent examples of the uptake of DigComp can be found in **Spain**, where a continuous professional development (CPD) program for teachers includes strong support for teachers' digital competence building and the development of digital training material. Both **Portugal** and **Lithuania** have implemented similar CPD initiatives, while in **Norway**, DigComp is used as an inspiration for a new national digital competence framework for teachers targeting both initial and in-service teacher training. A more holistic approach is taken in **Croatia**, where the "e-schools project" uses the DigComp framework to build its understanding of teachers' digital competence in digitally mature schools.

Another interesting use of the framework is as a background for designing assessment tools. In **Estonia**, starting in 2017, ninth graders will be assessed on their digital competence, an initiative that follows up on the inclusion of digital competence in the national curriculum in 2014. A similar project targeting teachers can be seen in **Croatia**, where an international research consortium has initiated a DigiComp [Note 22] project to facilitate hands-on understanding of the framework's competence areas by designing an online course platform to train teachers in confidently and critically using ICT in teaching, including cooperation, communication, and content-making.

Other notable EU-level frameworks aimed to support the fostering of digital competences in schools are the forthcoming European Commission Digital Competence Framework for Teachers (DigCompTeach), which highlights the specific need to understand digital competences in the teaching profession, and the European Framework for Digitally Competent Educational Organizations [Note 23] (DigCompOrg) (Kampylis et al. 2015), which complements other frameworks, such as the DIGCOMP framework.

Challenges and Developments in the European Region

When considering further developments in the region, it is appropriate to explore some of the pertinent challenges. We have already touched upon some of the major struggles the region is currently facing, such as increased immigration and terrorist threats. Furthermore, at the school level, we see other types of challenges related to curriculum integration, the professional digital competence of teachers, digital divides, and a weak association between the use of ICT and pupils' learning outcomes. The PISA 2012 results show that increased access to ICT is not synchronous with better learning outcomes in mathematics and reading (OECD 2015), and one reason may be that the potential of technology is not yet fully utilized.

The quantitative focus of (more) access to infrastructure, technological tools, and Internet connectivity supersedes the focus on a better pedagogical use of technology to optimize students' learning outcomes. Technology does not transform education

by itself; rather, it facilitates innovative, multimodal, and flexible learning. Moreover, technology adaption in schools needs to be viewed together with other aspects of school improvement and quality, such as school leadership, continuous professional development/lifelong learning of teachers, and assessment/evaluation systems.

Looking ahead, it is likely that the importance of lifelong learning and the continuous development of both learners and teachers over the course of their working lives will become the norm. Education systems will be informed by detailed and timely evidence through big data and developments in artificial intelligence. Pupils and teachers will be able to transport and combine education from various modes of formal and informal learning platforms. These shifts will lead to the development of formal qualifications, digital badges, ePortfolios, etc. (European Commission 2017).

However, though the European region is home to great disparities in access to technology and infrastructure, the user divide is even more prominent. We see great differences in teachers' competence when it comes to using technology within primary and secondary schools. Teachers claim that they need more training to gain the competence necessary to use technology in the classroom (OECD 2014b; European Commission 2013). Moreover, it is important to connect existing policies with actual practices and to understand that, despite good policy intentions, transferring them into practice is not an easy task. In addition to supporting good access and infrastructure, we also need school leaders and teachers to integrate policy intentions into local curricula. In accomplishing these objectives, we are dependent upon those school leaders and teachers who see the potential of ICT use for improving students' learning processes.

Professional Development of Teachers

In addition to primary and secondary education policies themselves, teachers' professional digital competence can also greatly influence the use and integration of policies at the school level. Therefore, we discuss this competence as an emerging theme in the region. Policy visions can be supported both by the provision of in-service training and by efforts to address the pedagogical use of ICT during the preservice training of primary and secondary school teachers.

The TALIS reports (OECD 2009, 2014b) reveals that teachers in primary and secondary education require more training in the use and integration of ICT into their practice. Teachers' professional digital competence is an important factor in ensuring the effective implementation of ICT education policies in primary and secondary education. Assisting teachers in developing their professional practice, knowledge, and skills in integrating ICT is an emerging theme in many European countries.

Professional digital competence refers to teachers' competence using ICT (i) as general basic tools, (ii) within the subject matter, and (iii) as a profession-oriented practice (e.g., to improve home-school communication, class leadership, relational competence, and teachers' own continuous professional development). Teachers

require both basic digital skills and critical skills to assess when it is (or is not) appropriate to use technology to teach their subject matter. Teachers, therefore, need to have knowledge and skills in technology, pedagogy, and content, as well as in the many possible combinations of these three, in order to embed ICT effectively into their teaching practice.

Competency frameworks focusing on the digital competence of teachers are being developed in several European countries in order to further assist teachers in integrating ICTs into their teaching and learning (see also section "Operational Policies" and the discussion on the DigComp framework). The UNESCO competence framework for teachers has been adapted and used to define teachers' competence in **Ireland** (Department of Education and Skills 2015). Similarly, in **Norway**, researchers and policy makers have developed a competence framework that provides structure for ICT integration in the teaching and professional learning of primary and secondary teachers as well as in teacher education [Note 24].

Job Automation and Youth Unemployment

Demographic changes and ICT have influenced what kinds of work and career paths are needed in the future. Following the 2007 financial crisis, millions of people in Europe lost their jobs, and young people with limited work experience were often hit the hardest. Youth unemployment is still high in several European countries. In addition, ICT is changing the ways in which we work. Artificial intelligence, the Internet of things, and big data are all influencing how we work, when we work, and where we work. Against a backdrop of rising inequality and shrinking job security, demands for entrepreneurship and the innovative and effective use of ICT are growing.

There is, therefore, a need to better coordinate education with the needs of the labor market in order to enable youth to gain necessary skills, reduce mismatches between job requirements and competence, and cope with challenges of increased competence and economic and social demands. Curricula must bridge boundaries between subjects and "cross the borders between subjects, between 'academic' and 'vocational' learning, and between the worlds of adults and students" (Hampson et al. 2016, p. 15). Such steps will enable youth to personalize their career choices and gain the competences necessary for their future careers.

Digital Citizenship

Learners in primary and secondary education today are born into a digital world. Though many call this generation "digital natives," it is important to remember that students who are familiar with technology do not necessarily know how to use educational resources and ICT for learning. For this reason, issues of digital citizenship are and will be of great importance both globally and within the European

region. The challenges teachers face concerning distracted students in technology-rich classrooms need to be addressed with strategies for class management (pedagogical, organizational, and technological). Challenges regarding online bullying and disrespectful communication and issues of privacy and copyrights are also of continuous concern within primary and secondary education in Europe. In this regard, efforts to incorporate policies promoting digital citizenship across the curriculum are critical. This message is underscored by research findings from the EU Kids Online project, which reported that children's chances of being exposed to hate messages and cyberbullying on the Internet rose significantly between 2010 and 2014 (EU Kids Online 2014).

Conclusion and the Way Forward

We have now discussed some of the policy initiatives targeting primary and secondary education in Europe. In so doing, we have identified several national and local initiatives and more holistic policy plans involving the EU and the European region as a whole. However, needless to say, the limitations of this chapter are abundant, and it is impossible to cover all the positive initiatives that are worth mentioning.

It is difficult to forecast developments and upcoming challenges within the field of ICT. One way to address future developments is to describe or predict some of the technological changes and developments that are likely to occur. Instead of taking this route, we chose instead to focus on some of the qualitative and pedagogical aspects influencing technology adoption. Therefore, we discussed three challenges that we are already facing: (i) teachers' professional digital competence, (ii) changes in the world of work and the importance of lifelong learning processes, and (iii) the increased focus on digital citizenship and digital responsibility.

The European region faces several challenges involving the integration of ICT in primary and secondary education. Some of these have been briefly mentioned in this chapter. However, supplementing teaching methods with ICT is only as effective as the teacher leading the teaching/learning process. In other words, ICT will never replace "traditional" teaching methods and/or teachers. The biggest challenge is, perhaps, how we assess empirical and research-based evidence to determine what works and when and to learn how the variety of pedagogical approaches and methods/tools in the classroom can lead to better learning for students. This challenge applies not only to ICTs but also to every method or means teachers use in the classroom. It can, in short, be defined as the challenge of leveraging evidence-based practices and policies to further develop education.

End Notes

1. See further http://unstats.un.org/unsd/methods/m49/m49regin.htm#europe
2. See, e.g., http://www.dw.com/de/das-aus-f%C3%BCr-schulen-ans-netz/a-16481641

3. These are Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kosovo, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Russia, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom.
4. Calculations based on TIMSS 2015 exhibit 9.5 and 9.6 (http://timssandpirls.bc.edu/timss2015/international-results/timss-2015/mathematics/classroom-instruction/computer-activities-during-mathematics-lessons/)
5. PISA results are based on data on 15-year-old students, a population usually assigned to upper secondary schools in European countries. TIMSS covers the populations of both fourth graders (typically in primary schools) and eighth graders (typically in lower secondary schools). TIMSS 2015 was released at the same time as PISA 2015; thus, the studies are chronologically comparable.
6. These are England, Hungary, Ireland, Italy, Lithuania, Malta, Norway (grade 9), the Russian Federation, Sweden, Slovenia, and Turkey.
7. These are Denmark, Netherlands, Sweden, Norway (grade 5), England, Germany, Finland, Cyprus, Ireland, Belgium (Flemish), Italy, Spain, Poland, Lithuania, Turkey, the Czech Republic, Hungary, Bulgaria, the Slovak Republic, Portugal, France, Slovenia and Serbia.
8. With high equipment levels, large numbers of network access points, routers and switches, highly Wi-Fi connected classrooms, high use of cloud for hosting, BYOD policy and BYOD support.
9. With relatively low levels of equipment, low classroom Wi-Fi provision and services hosted in school.
10. https://digabi.fi/?lang=en_US
11. See further www.mi4u.ch
12. See further http://hitsa.ee/about-us
13. See further http://www.iea.nl/fileadmin/user_upload/Studies/ICILS_2018/IEA_ICILS_2018_Computational_Thinking_Leaflet.pdf
14. See further http://ec.europa.eu/programmes/erasmus-plus/node_en
15. See further http://ec.europa.eu/social/main.jsp?catId=1223
16. See further http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOC_2016_484_R_0001
17. See further http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32006H0962
18. See further https://ec.europa.eu/education/policy/strategic-framework/expert-groups_en
19. http://www.eun.org/
20. http://www.istruzione.it/scuola_digitale/allegati/Materiali/pnsd-layout-30.10-WEB.pdf
21. https://education.gov.mt/elearning/Documents/Green%20Paper%20Digital%20Literacy%20v6.pdf
22. http://www.digital-competences-for-teachers.eu/
23. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC98209/jrc98209_r_digcomporg_final.pdf

24. See further https://www.udir.no/globalassets/filer/in-english/pfdk_framework_en_low2.pdf

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