EUROPEAN
COMMISSION

Brussels, 17.1.2018
SWD(2018) 12 final

COMMISSION STAFF WORKING DOCUMENT
Accompanying the document

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions

on the Digital Education Action Plan

{COM(2018) 22 final}

1) Introduction

This staff working document complements the Communication on the 'Digital Education Action Plan'. It is structured to reflect the three priorities set out in the Action Plan and provides analysis and evidence to underpin these priorities and the actions linked to them:

- Priority 1: Making better use of digital technology for teaching and learning;
- Priority 2: Developing relevant digital competences and skills for the digital transformation;
- Priority 3: Improving education through better data analysis and foresight.

For the purposes of this document, the word 'education' is generally understood as a sector neutral term. However, the Digital Education Action Plan has a specific focus on initial education and training systems and covers schools, VET and higher education.

Priority 1: Making better use of digital technology for teaching and learning

Digital technology enriches education and offers new learning opportunities. The internet can open the learning experience to an unprecedented wealth of information, and provides a wide range of resources and tools applicable to any domain of knowledge and educational sector. The abundance of information allows all users to interact with learning content on their own or in formal and non-formal educational settings.

Digital technology allows citizens to be not just passive consumers, but also creators of value, for instance when creating and sharing digital outputs such as texts, visuals, videos, audio recordings and music, or apps and software. Digital technology facilitates problem-based and interactive learning,[1] and enables a personalisation of the learning experience. Learning, even at the highest levels of specialisation, is becoming increasingly accessible because of the affordances of technology. For instance, this happens with access to education[2] offered through Massive Open Online Courses (MOOCs), thus expanding the pool of students and opening opportunities for a diversified cohort of learners.

Digital technology can improve results in education,[3] in particular by enabling access to additional learning resources, and supporting disadvantaged students, such as those from low socioeconomic backgrounds,[4] or with disabilities, or living in remote areas. In a broader way, digital technologies offer new ways to organise and structure teaching and learning.[5] All sectors of education are

---

[1] European Commission. (2017). *Commission Staff Working Document, Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A renewed EU agenda for higher education* SWD(2017)264 https://ec.europa.eu/education/sites/education/files/he-swd-2017-165_en.pdf

[2] Goodman, J., Melkers, J., & Pallais, A. (2016): *Can online delivery increase access to education*? Harvard Kennedy School Faculty Research Working Paper Series. RWP16-035.

[3] European Commission. (forthcoming). Digital Education Policies in Europe and Beyond. A Discussion of exemplary cases, JRC Science for Policy Report.

[4] European Commission. (2017). *Commission Staff Working Document, Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A renewed EU agenda for higher education.* SWD(2017)164 https://ec.europa.eu/education/sites/education/files/he-swd-2017-165_en.pdf

[5] European Commission. (2017). *A renewed EU agenda for higher education.* COM(2017)247 https://ec.europa.eu/education/sites/education/files/he-com-2017-247_en.pdf

increasingly making use of digital technologies to stimulate educational innovation and personalisation of learning.[6]

Although since 2011 all EU countries have adopted strategies for using digital technology in education, there is a long way to go before the full potential as a tool for learning and teaching is reached. The impact of technology in changing educational practices is currently less evident than it was hoped for.[7]

1.1 Ensuring equity in and quality of access and infrastructure

Leveraging the potential of digital technologies for education is first and foremost a question of improving education. In this frame, the focus is – or should be – not on the digital technology per se, but rather on the pedagogy.[8] Digital technology can in fact be integrated in education as an expensive upgrade of other tools, or otherwise being the trigger of innovation, thus enabling tasks and activities that could have not been possible without the uptake of digital tools.[9] Nonetheless, access (in terms of both infrastructure and connectivity) remains the first layer of a digital divide in education in several parts of Europe.[10]

A lack of access in schools cannot necessarily be balanced through connectivity and devices at home – as of 2016 only 85% of households had internet access, with a household connectivity rate between 97% (LU, NL) down to 72% (LI, RO), 69% (EL) and 64% (BG).[11] While nonetheless the majority of youth makes use of the internet[12], it is clear that there are disparities between those young people from well-equipped households and those living in households without any internet access. Large differences in terms of NGA (Next Generation Access) coverage can be particularly observed between rural and urban areas: access to NGA technologies allowing superfast broadband coverage was only available in 40% of rural homes in 2016 (compared to 30% in 2015). [13] The connectivity of schools thus plays an important role in ensuring that all young Europeans have access to the same opportunities offered by the digital sphere.

Data referring to school **infrastructure**, considering connectivity and devices, has been collected in 2013[14]. Then, the student to computer ratios in European schools ranged from 3:1 to 7:1 (students:computers). Laptops, tablets and netbooks were becoming pervasive in some countries, and interactive whiteboards started to be present for a minority (over 100 students per interactive whiteboard). The Commission study however highlighted significant differences across countries in relation to digital equipment and its availability per students. While wide differences in ratio between

---

[6] European Commission. (2017). *Commission Staff Working Document, Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A renewed EU agenda for higher education* SWD(2017)264 https://ec.europa.eu/education/sites/education/files/he-swd-2017-165_en.pdf

[7] OECD (2016). Innovating Education and Educating for Innovation. The Power of Digital Technologies and Skills. Paris: OECD Publishing. Retrieved October 01, 2016 from http://dx.doi.org/10.1787/9789264265097-en

[8] LLL Platform. (2017). *Reimagining Education for the Digital Age.* http://lllplatform.eu/lll/wp-content/uploads/2015/09/DigitalPaper_final-1.pdf

[9] European Commission. (2012). Towards a mapping framework of ICT-enabled innovation for learning. JRC Scientific and Policy Reports. EUR 25445 EN. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/towards-mapping-framework-ict-enabled-innovation-learning

[10] European Commission. (2017). *Satellite broadband for schools: Feasibility study.* doi:10.2759/835661. ec.europa.eu/newsroom/document.cfm?doc_id=46134

[11] Eurostat. (2016). *Households - level of internet access.* http://ec.europa.eu/eurostat/product?code=isoc_ci_in_h&language=en&mode=view

[12] Eurostat. (2016). *Individuals - internet use* http://ec.europa.eu/eurostat/product?code=isoc_ci_ifp_iu&language=en&mode=view

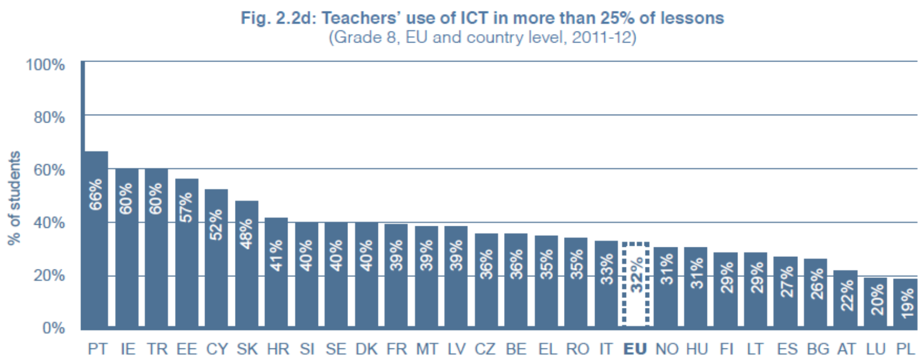
[13] European Commission. (2017). *Europe's Digital Progress Report 2017 – Connectivity.* http://ec.europa.eu/newsroom/document.cfm?doc_id=44389

[14] European Commission. (2013). *Survey of Schools: ICT in Education Benchmarking Access, Use and Attitudes to Technology in Europe's Schools* https://ec.europa.eu/digital-single-market/en/news/survey-schools-ict-education The upcoming 2nd survey is to be published in 2018.

and within countries are still to be seen in the preliminary results of the upcoming second survey, to be published in 2018, it should also be noted that the uptake of digital technologies for education refers to a wide range of devices and, most importantly, of practices. For instance, educational robotics is currently a promising developing field. Robots are used in education to stimulate or accompany young people in developing a variety of competences, from STEM to humanities, and as a means to develop cognitive and social skills.[15] On the same strand, 'making' and 'tinkering', concepts from the maker movement,[16] are increasingly finding their ways in different sectors of education as an innovative way to engage with digital technology from a design and inventor perspective.[17] These practices are based on both technological developments and pedagogical innovation. At the same time, they provide a hint on how the infrastructure for educational purposes can be rich, varied and differentiated.

The availability of infrastructure does not always equal the **frequency of use** of digital technology. In this respect, the Commission 2013 survey showed that large differences between Member States also exist related to teachers' regular use of digital technologies for their teaching. Whereas two thirds of teachers in Portugal teaching 13 year old pupils regularly used digital technology in their classes, only 19 % in Poland reported doing so (see Figure 1).

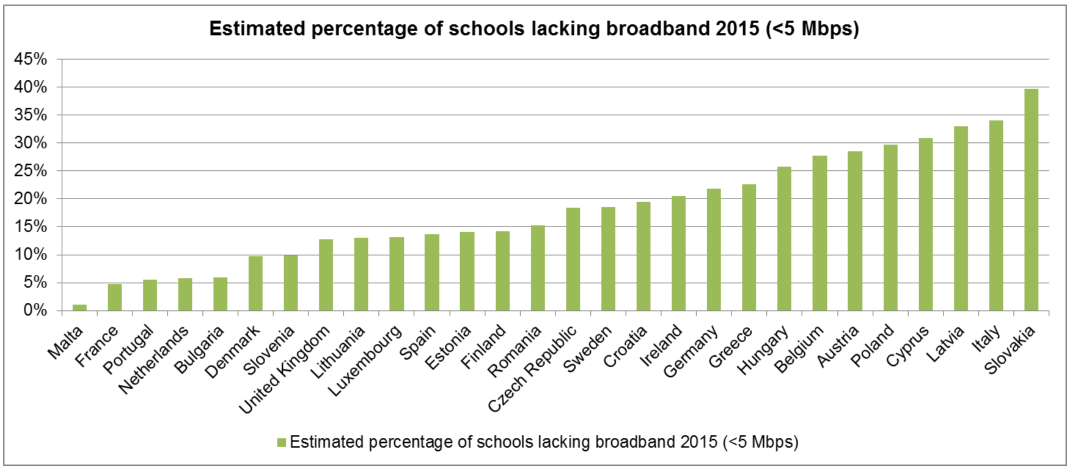
Figure 1: Teachers' use of digital technology in more than 25% of lessons in Grade 8 (2011-2012)[18]



In terms of **connectivity**, household survey data from 2013 indicated that while more than 72% of individuals were making use of the internet at home and 32% at the place of work, only 10% indicated that they had in the past year used the internet at a place of education.[19] In some Member States, schools are already connected to broadband, whereas other member states are clearly lagging behind (see Figure 2).

[15] Alimisis, D. (2013). Educational robotics: Open questions and new challenges. Themes in Science and Technology Education, 6(1), 63-71.
[16] A loose group of "*hobbyists, engineers, artists, designers, hackers, and craftsmen are exploring new ways for personal expression by hacking and remaking their physical world as they see appropriate.*" For an introduction, see: European Commission. (2017). *Overview of the Maker Movement in the European Union*, EUR 28686 EN. Doi: 10.2760/227356. https://ec.europa.eu/jrc/en/publication/overview-maker-movement-european-union
[17] Vossoughi, S., & Bevan, B. (2014). Making and tinkering: A review of the literature. *National Research Council Committee on Out of School Time STEM*, 1-55.
[18] European Commission. (2013). *Survey of Schools: ICT in Education Benchmarking Access, Use and Attitudes to Technology in Europe's Schools* https://ec.europa.eu/digital-single-market/en/news/survey-schools-ict-education
[19] Eurostat, 2013: Individuals' internet use by place of use http://ec.europa.eu/eurostat/web/products-datasets/product?code=isoc_ci_ifp_pu

Figure 2: Estimated percentage of schools lacking broadband in 2015 (<5 Mbps)[20]



Poor connectivity limits the opportunities that are offered by technology. Connecting schools to ultra-fast broadband is particularly crucial given that schools often rely on one single connection/subscription that serves multiple users at the same time (e.g. students and teachers), enhancing the need to ensure speed and quality of experience.[21] Already now, a school of 20 classes with 20 pupils each would require speeds of 700 Mbps for simultaneous use.[22] Being connected offers many advantages to schools: access to resources and specialised material in multiple formats; platforms for collaboration; tools for inquiry-based pedagogies (e.g. virtual labs); and sophisticated online software (e.g. simulation, serious games, etc.).[23]

Schools are increasingly requesting bandwidth demanding applications (such as video conferencing, high-quality video streaming, or cloud computing). Video conferencing, for instance, can create great opportunities for both teachers and pupils, e.g. by inviting outside speakers/experts for a specific class who would otherwise not be available, or by linking students with others from different communities, backgrounds and cultures. In addition, so-called "next-generation" applications for innovative learning and teaching like virtual reality (VR) or augmented reality (AR) could require extremely fast Internet access speed close to 1 Gpbs.[24] A growing body of research suggests that "immersive learning" enabled by virtual environments may offer a powerful catalyst to increase students' learning experience. Virtual environments provide embodied experiences allowing to see, hear and feel digital stimuli as if in the physical world,[25] and thereby allowing access to experiences that rely on scarce or access-limited resources (e.g. flying to the moon) or that are physically impossible (e.g. exploring a molecule from the inside).[26]

---

[20] European Commission. (2017). Satellite broadband for schools: Feasibility study. http://ec.europa.eu/newsroom/document.cfm?doc_id=46134

[21] European Commission. (2016). *Commission staff working document accompanying the communication "Connectivity for a competitive digital single market – Towards a European Gigabit Society"* SWD(2016)300. https://publications.europa.eu/en/publication-detail/-/publication/5655ecd7-7a51-11e6-b076-01aa75ed71a1

[22] European Commission. (2016). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society*. COM(2016)587. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016AE5303

[23] OECD (2015). *Students, Computers and Learning: Making the Connection*, PISA, OECD Publishing.

[24] European Commission. (2016). *Commission staff working document accompanying the communication "Connectivity for a competitive digital single market – Towards a European Gigabit Society"* SWD(2016)300. https://publications.europa.eu/en/publication-detail/-/publication/5655ecd7-7a51-11e6-b076-01aa75ed71a1

[25] Ahn, S. J. G., Bailenson, J. N., & Park, D. (2014). Short-and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behavior. *Computers in Human Behavior*, *39*, 235-245

[26] Greenwald, S., Kulik, A., Kunert, A., Beck, S., Frohlich, B., Cobb, S, & Snyder, A. (2017). Technology and applications for collaborative learning in virtual reality. *CSCL 2017 Proceedings*, p. 719 – 726.

Broadband infrastructure must therefore keep pace with the schools' growing needs for broadband internet access. However, there is still a long way to go in order to achieve the target to connect all schools in Europe to high-speed broadband by 2025. Appropriate broadband infrastructure can only be considered as a "*conditio sine qua non*": it can help enhance great teaching and learning, but only if all aspects of digital integration in an organisation are considered.[27] The EU broadband targets, set under the European Gigabit Society strategy, foresee that by 2025, all schools, transport hubs and main providers of public services as well as digitally intensive enterprises should have access to Gigabit internet connectivity[28].

Accessibility and quality of connectivity are paramount to ensure **equity**. Disadvantaged students such as those from low-income or migrant backgrounds with limited amount of resources have less access to computers outside the school, start using digital devices later in life (e.g. only 69% of disadvantaged students used them before the age of 10, compared to 77% of medium socio-economic students and 83% of students from more advantaged backgrounds), and use ICT less frequently outside of school to do schoolwork, and to communicate with classmates and teachers about schoolwork than their more advantaged counterparts.[29] Indeed, access to technology goes beyond the classroom: it applies to all educational sectors – thus being the first enabling conditions for all educational actors – and spills to the need of the household, where learning is also taking place. A hidden side of the digital divide has been labelled as "the homework gap",[30] referring to the differences in access in the household and their consequences for self-study.

1.2 Organisational change

Even if access is a pre-condition, it does not necessarily enable educational change. Education systems are currently adapting to the changing nature of learning and the new demands spurring from the needs of learners, society, and the labour market.[31] Thus, the current trend goes towards holistic models targeting systemic rather than infrastructure or content related changes. This trend is supported by research evidence, as it has been proven that interventions that are limited to providing students with access to technology yield largely mixed results.[32] Analysis of 1:1 initiatives (i.e. initiatives that aim at equipping each student of a given school, class or age group with portable devices) underline that for these interventions to bring improvement in education, the initiative must be systemic and underpinned by pedagogical values.[33]

[27] European Commission. (2015). *Promoting Effective Digital-Age Learning: A European Framework for Digitally-Competent Educational Organisations*, DOI: 10.2791/54070. http://dx.doi.org/10.2791/54070

[28] European Commission. (2016). *Commission staff working document accompanying the communication "Connectivity for a competitive digital single market – Towards a European Gigabit Society"* SWD(2016)300. https://publications.europa.eu/en/publication-detail/-/publication/5655ecd7-7a51-11e6-b076-01aa75ed71a1

[29] European Commission. (2017). *Digital technologies and learning outcomes of students from low socio-economic background: An analysis of PISA 2015*. JRC Science for Policy Report, EUR 28688 EN. http://dx.doi.org/10.2760/415251

[30] Meyer, L. (2016). Home connectivity and the homework gap. *THE Journal (Technological Horizons In Education)*, *43*(4), 16.

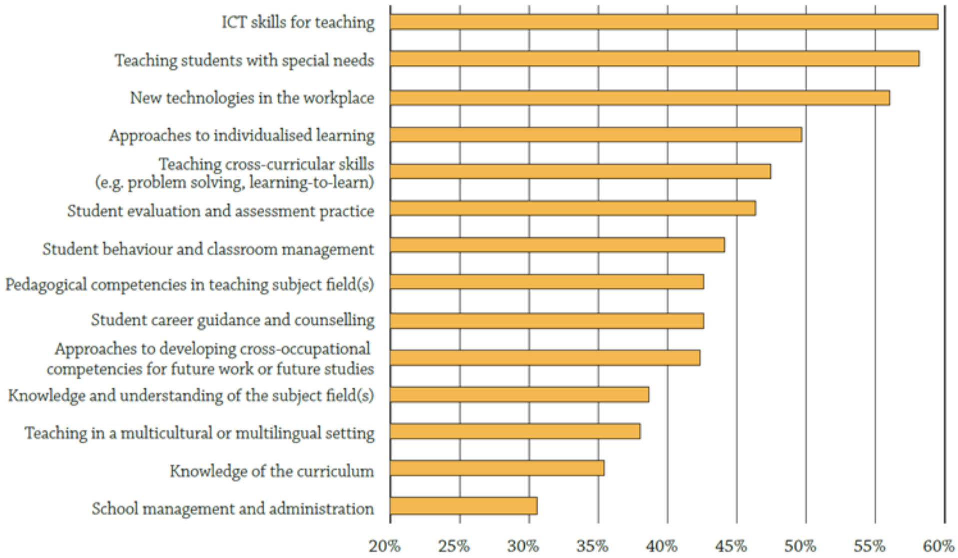
[31] OECD. (2015). *Education Policy Outlook 2015: Making Reforms Happen*. Paris: OECD; Fullan, M. (2010). All systems go: The change imperative for whole system reform. London: Corwin Press/SAGE.

[32] European Commission. (2017). *Digital technologies and learning outcomes of students from low socio-economic background: An analysis of PISA 2015*. JRC Science for Policy Report, EUR 28688 EN. http://dx.doi.org/10.2760/415251

[33] European Commission (2013). *Overview and analysis of 1: 1 learning initiatives in Europe*, JRC Scientific and Policy Reports. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6199

Deep integration of technology requires significant educational innovation and implies a process of planning for pedagogical, technological and organisational change.[34] While in previous decades policy reform on digital education often focused on the number of devices or the proportion of connected schools, today education reform in Europe tends to take a more comprehensive approach which includes in particular a focus on pedagogy and on how technology can and should be used. Policy interventions thus move along those priorities. Third generation digital education policy aims not just to provide infrastructure and devices (first generation), or to accompany this provision with measures such as teacher training and content development (second generation), but works towards integrating digital education more firmly in overall education and innovation policies.[35] A current focus is in particular on ensuring that technologies augment and improve, rather than just replace learning in and outside the classroom[36] and the teacher's ability to do so.[37] Digital technology for learning is more likely to have a positive effect if educators are trained to use them effectively.[38] A high share of teachers at lower secondary education indicated in a survey that they have a moderate or high need for professional development in pedagogical digital competences. This surpassed any other training needs teachers were consciously aware of (see Figure 3).[39]

Figure 3: Percentage of lower secondary education teachers indicating their *moderate* or *high* level of need for professional development in specific areas



Source: OECD, TALIS 2013 Database, *http://dx.doi.org/10.1787/888933045183*, Table 4.12.Web.

[34] European Commission (2014). *Mainstreaming ICT enabled Innovation in Education and Training in Europe-Policy actions for sustainability, scalability and impact at system level*, JRC Scientific and Technical Research Reports, EUR 26601; European Commission (2013). *ICT-enabled innovation for learning in Europe and Asia. Exploring conditions for sustainability, scalability and impact at system level*. JRC Scientific and Policy Report.
[35] European Commission. (forthcoming). *Digital Education Policies in Europe and Beyond. A Discussion of exemplary cases*, JRC Science for Policy Report.
[36] The nature of ICT-enabled innovation for learning is often described with progressive levels using terms such as incremental, radical or disruptive as suggested in: European Commission. (2012). *Towards a mapping framework of ICT-enabled innovation for learning*. JRC Scientific and Policy Reports, EUR 25445 EN.
[37] European Commission. (2014). *The International Computer and Information Literacy Study (ICILS): Main findings and implications for education policies in Europe.* ec.europa.eu/dgs/education_culture/repository/education/.../study/.../ec-icils_en.pdf
[38] European Commission. (2014). *The International Computer and Information Literacy Study (ICILS): Main findings and implications for education policies in Europe.* ec.europa.eu/dgs/education_culture/repository/education/.../study/.../ec-icils_en.pdf
[39] OECD. (2013). Talis Database. http://www.oecd.org/edu/school/talis.htm

Awareness in EU Member States about this need is high[40] and this is the concern most frequently raised in discussions of European policy makers working on digital issues.[41] At policy level, this need has been stressed repeatedly and has been identified as one of the priority areas for European cooperation in Education and Training.[42] Competences of educators refer not only to their ability to understand and use digital technology but rather to their capacity to use digital technology for teaching and learning. This implies acquiring and developing professional and pedagogical competences. Responding to this need identified by both research and policy makers of Member States and stakeholder organisations, the European Commission developed a framework for the Digital Competence of Educators.[43] Effective integration of digital technologies for the benefits of students and staff implies a reflective approach[44] that includes, besides teacher training, curricula and educational materials that are fit for digitally-supported teaching models,[45] and assessment practices that benefit from the opportunities offered by digital tools.

Indeed, several Member States (MS) have developed digital strategies for schools to support educational organisation to improve their use of digital technology. For instance, the Irish Digital Strategy for Schools 2015-2010[46] underscores the need for a Digital Learning Framework that can be used by school leaders, subject departments and individual teachers to guide and review progress in the embedding of digital technologies in all aspects of teaching and learning. There are other examples of Member States who developed self-assessment tools for schools' digital capacity (e.g. Opeka tool in Finland, Digital Schools of Distinction in Ireland, Digital mirror in Estonia, Castilla y Leon Region in Spain, to name a few). Among different tools that support the self-assessment of digital readiness, SELFIE (Self-assessment tool for digitally capable schools)[47] is an example of an organisational change approach. With a pilot involving 650 schools in 14 countries, SELFIE provides a practical tool for school to self-assess their digital readiness in several domains, namely: leadership and governance, infrastructure, content & curricula, assessment practices, professional development, teaching & learning practices, collaboration & networking. The different areas of SELFIE provide a clear indication on the different aspects that underpin organisational change with the aim of harnessing the potential of technology in all aspects of education.

There is a growing digital gap between educational organisations in the way they are reaping the benefits of digital technology. One solution to narrow this gap is the promotion of a mentoring scheme. A grassroots school environment can be conducive to the take up of technologies between schools with various levels of technological proficiency and readiness with the objective of supporting greater collaboration both within and between schools and peer-to-peer exchanges.

The methodology of the Living School Labs[48] has been successfully used in the past and can be scaled-up. It involved 12 Ministries of Education across Europe and created regional hubs which in some countries were highly effective in coordinating activities. Two advanced schools in each

---

[40] European Commission. (2017). *European Framework for the Digital Competence of Educators (DigCompEdu)*, JRC Science for Policy Report, EUR 28775 EN. https://ec.europa.eu/jrc/en/digcompedu

[41] This is reflected for instance in the Key Messages of the ET2020 Working Group on Digital Skills and Competences https://ec.europa.eu/education/policy/strategic-framework/expert-groups/digital-skills-competences_de

[42] 2015/C 417/04: Joint Report of the Council and the Commission on the implementation of the strategic framework for European cooperation in education and training (ET 2020): New priorities for European cooperation in education and training.

[43] European Commission (2017). European Framework for the Digital Competence of Educators (DigCompEdu), JRC Science for Policy Report, EUR 28775 EN. https://ec.europa.eu/jrc/en/digcompedu

[44] Such an approach is proposed in: European Commission. (2017). *European Framework for the Digital Competence of Educators (DigCompEdu)*, JRC Science for Policy Report, EUR 28775 EN. https://ec.europa.eu/jrc/en/digcompedu

[45] OECD. (2015). *Students, Computers and Learning: Making the Connection*. Paris: OECD Publishing. and OECD. (2017). *Innovating Education and Educating for Innovation: The Power of Digital Technologies and Skills*. Paris: OECD Publishing.

[46] Digital Strategy for Schools 2015-2010: http://www.education.ie/en/Publications/Policy-Reports/Digital-Strategy-Action-Plan-2017.pdf

[47] European Commission (2017). SELFIE –Tool: https://ec.europa.eu/jrc/en/digcomporg/selfie-tool

[48] http://lsl.eun.org/

participating country were mentoring five less advanced counterparts, with several hundreds of teachers involved. Virtual trainings were also offered (Recordings of webinars were also made available on the website and these have been watched by an average of 2500 people and the observation blog seen by over 200,000 people). The project provided a strong proof of concept for the whole-school approach in adopting ICT, the relevance of peer-learning among teachers, the importance of schools leadership and regional hubs in mainstreaming change. This initiative provided a methodology that can be scaled up across Europe.

1.3. Connecting innovators in education

From the public consultation of the Erasmus+ mid-term evaluation, 68% of respondents indicated that improving the quality, innovation and internationalisation of education is an 'extremely relevant' objective to the challenges the field faces in the digital age.

Digital technology is recognised as an enabler of innovation in education. In this context, innovation is perceived as a newness that brings value.[49] All educational sectors benefit when innovative process, practices, tools, experiences and materials are shared. Nevertheless, it is known that, although pockets of innovation exist both in education and research, they tend to operate in 'splendid isolation'.[50]

For educators, it is neither common nor easy to communicate about their work.[51] The same applies to those who bring innovation at policy level. Innovation – especially in education, where it often happens behind closed doors – thus faces the challenge to be visible, and consequently to widespread, and scale-up. Recent attempts to map educational innovation initiatives in Europe have been carried out, for instance with the 'Open Book of Educational Innovation',[52] which can serve as inspiration to further spur innovative approaches elsewhere. This approach – sharing of best practices – is one of the most common tools at EU level to exchange knowledge and experiences in education.

Unlike innovation in the marketplace, innovation in education thrives through exchange. Bringing together different actors to improve education allows for change to take place and widespread. Collaboration and exchanges can happen in different ways: among stakeholders working on the same level (for instance, bringing together educators, or creating collaborative actions among policy-makers) or by connecting actors that work at different levels (for instance, matching educators with industry, or policy-makers and practitioners).

Peer exchanges, both at policy level and between teachers, are proven to support the mainstreaming (or wide-spreading) of innovation. At policy level, the uptake of computing in formal school curricula is a notable example. When the UK[53] pioneered the political decision in 2014 to make computing compulsory for all schools from primary level, it set an example for other Member states to follow the

[49] Kirland, K. and Sutch, D. (2009). *Overcoming the barriers to educational innovation*. Bristol. Futurelab. https://www.nfer.ac.uk/publications/FUTL61/FUTL61.pdf
[50] https://ec.europa.eu/research/openvision/pdf/rise/030616_pockets_of_excellence.pdf
[51] Licht, A.H, Tasiopoulou, E., Wastiau, P. (2017). *Open Book of Educational Innovation*. European Schoolnet. Brussels. www.eun.org/documents/411753/.../Open_book_of_Innovational_Education.pdf
[52] Licht, A.H, Tasiopoulou, E., Wastiau, P. (2017). *Open Book of Educational Innovation*. European Schoolnet. Brussels. www.eun.org/documents/411753/.../Open_book_of_Innovational_Education.pdf
[53] The reform took place in England. Note that since devolution of political power from 1997 onwards, different approaches to National Curricula apply in England, Scotland, Northern Ireland, and Wales.

same trend.[54] Indeed, other countries followed the same path – with Ministries of Education clearly stating that the example of the UK set a trend. Exchanges between Ministries of Education in Europe are managed through the Open Method of coordination.[55] In this, the Commission and Member States cooperate in the form of Working Groups, which are designed to help Member States address the key challenges of their education and training systems through peer exchange.

At the level of practitioners, exchanges between teachers and educators are happening in several member states and at EU level. The biggest educational network in Europe is certainly eTwinning.[56] In the 12 years since its launch, 500,000 teachers have registered to use it as a place to exchange practices and organise online classroom-to-classroom projects with their pupils. The community is based on the principle of exchange between educators, for the purpose of learning from each other. The European Commission facilitated moreover the Teacher Academy[57], which offers to all teachers in Europe the possibility to pursue free professional development in the form of MOOCs. In its two years of existence, it attracted thousands of teachers and boasts high completion rates above the global average.

Open Educational Resources and Open Educational Practices are as well a form of peer exchange that supports the widespread of innovation. In Europe, OER projects have been initiated in many countries, with the Netherlands and the UK being recognised as the European pioneers in the field.[58]

It is recognised that large scale and systemic innovation sees the alliances of the 'bees' (the creative individuals with ideas and energy) and the 'trees' (the big institutions with the power and money to make things happen to scale).[59] In the educational sector, connecting bees and trees entails connecting policy-makers and teachers. Currently, the School Education Gateway[60] offers opportunities for such an exchange. Presented in 23 European languages, the School Education Gateway is a single point of entry for teachers, school leaders, policy makers, experts and other professionals in the field of school education.

Innovation in education is reaching out to stakeholders beyond schools and educational organisations. Business-education partnerships are currently becoming more common. The initiative lead through the Pact4Youth,[61] for instance, aims at making business-education partnership the new norm. A specific case where this cooperation lead to innovative educational approaches can be seen in the Future Classroom Lab (FCL),[62] an inspirational learning environment that challenges the role of pedagogy, technology and design in the classrooms. The FCL is supported by a network of Ministries of Education in cooperation with industry partners. Moreover, the FCL inspired new uptakes in several member states, thus creating a network of Future Classroom Labs all over Europe that serve as innovative hubs for their country or region.

---

[54] European Commission. (2016). *Developing computational thinking in compulsory education - Implications for policy and practice*. JRC Science for Policy Report, EUR 28295 EN; doi:10.2791/792158. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/developing-computational-thinking-compulsory-education-implications-policy-and-practice

[55] https://ec.europa.eu/education/policy/strategic-framework/expert-groups_en

[56] www.etwinning.net

[57] https://www.schooleducationgateway.eu/en/pub/teacher_academy.htm

[58] http://www.cedefop.europa.eu/en/publications-and-resources/publications/4149?src=email&freq=weekly

[59] Murray, R. Caulier-Grice, J. Mulgan, G. (2010). *Open book of social innovation*. Nesta. https://www.nesta.org.uk/publications/open-book-social-innovation

[60] www.schooleducationgateway.eu

[61] https://www.csreurope.org/pactforyouth

[62] http://fcl.eun.org/

1.4. Digital technologies to support mobility

Mobility of students within the EU is a crucial factor to develop Europe's highly skilled labour force in order to strengthen its position as a knowledge-based economy. International student mobility is currently very concentrated in few countries in the case of degree mobility, while more equally distributed across Member States in relation to international credit mobility.[63] Evidence on the benefits of student mobility shows that studying abroad helps a person cope more successfully with increasing international dimensions at work and helps with career enhancement.[64] Evidence shows that international students are likely to stay and work in the host country once they have completed their studies,[65] and international mobility increases their probability of working abroad later in life.[66] Mobility improves international competences,[67] foreign language skills and intercultural knowledge and promotes personal and academic growth.[68] Besides these benefits, student mobility is also a prime mechanism to foster a sense of European identity and citizenship.[69]

The November 2017 European Commission Communication on Strengthening European Identity through Education and Culture[70] identifies boosting mobility and facilitating cross-border cooperation as one of the key areas for action. The Erasmus+ Programme and more recent initiatives such as Move2Learn - Learn2Move[71] have been identified as positive examples that give young Europeans the chance to discover and learn about Europe, improve their skills, and increase their chances in the labour market. However, currently only 3.7% of young people have the chance to take part in mobility activities of this kind.

The November Communication therefore calls for doubling the number of participants in the Erasmus+ Programme by 2025 and reaching out to learners coming from disadvantaged backgrounds. Key challenges for such an expansion are the heterogeneity of institutions and legal frameworks in the school education sector and limitations on the possible duration of both teacher and learner mobility. Under the current Erasmus+ Programme, around 100,000 pupils per year participate in short group exchanges of one to two weeks, while less than one thousand participate in individual exchanges longer than two months. In the context of the Erasmus+ Programme, digital technology offers a possibility for more sustainable cooperation projects, where physical mobility is complemented with more frequent virtual interactions, extending the exchanges between individuals and schools over a longer period of time.

The success of the eTwinning platform[72] proves the potential for such an action. The 2013 study on the platform's impact found that it is "unique in this scale and scope and has no precedent or

[63] European Commission. (2017). *Student mobility in tertiary education*, EUR 28867 EN. doi: 10.2760/675338.
[64] Teichler, U. (2007). International dimensions of higher education and graduate employment, REFLEX report. REFLEX, The flexible professional in the knowledge society. New demands on higher, project supported by the VI framework programme of the EU, 199–220.
[65] Rosenzweig, M. (2008). *Higher education and international migration in Asia: Brain circulation*. Annual World Bank conference on development economics (pp. 59–100).
[66] Oosterbeek, H. and Webbinkz, D. (2011). Does Studying Abroad Induce a Brain Drain? *Economica* 78, 347–366
[67] Bracht, O., Engel, C., Janson, K., Over, A., Schomburg, A. and Teichler, U. (2006). *The professional value of Erasmus mobility*. Kassel, Germany: International Centre for Higher Education Research, University of Kassel.
[68] Sorrenti, G. (2017), The Spanish or the German apartment? Study abroad and the acquisition of permanent skills, *Economics of Education Review*, Vol. 60, pp. 142-158.
[69] Rodríguez-González, C.; Bustillo-Mesanza, R. and Mariel, P. (2011) The determinants of international student mobility flows: an empirical study on the Erasmus programme. *Higher Education* 62: 413-430.
[70] https://ec.europa.eu/education/news/20171411-strengthening-european-identity-through-education-and-culture_en
[71] Move2Learn - Learn2Move has been implemented through a link with eTwinning, by granting funds to schools carrying quality labels for their previous eTwinning projects. 5000 participants have received support as part of a special call, providing additional proof of the potential demand for projects of this type.
[72] www.etwinning.net

comparator within or outside Europe."[73] The same study found a number of positive results at the level of the schools, teachers and pupils using the platform, including the participants' improvement and development of digital competences. The participating teachers as well as the implementing services of Member States[74] report that the inability to eventually complement the online eTwinning projects with physical interaction is a lost opportunity. Physical mobility provides further benefits, including positive impact on language skills, social and civic competences, cultural awareness, and digital competences.[75]

Digital technology can play a crucial role not only in allowing for blended approaches to mobility, but as well to support the pragmatic aspects of students' mobility. However, the benefits that digital technology can bring are currently unmet, as pointed in the "Student mobility in a digital world" project.[76] The study collected data from students participating in mobility programmes from 32 countries and almost 400 universities. Student reported difficulties in continued access to the digital services they needed during their stay, with a majority claiming that they used digital services from their home university rather than their host one.

There are already some relevant initiatives at European level for reaping the benefits of digital technologies in students' mobility. The mutual recognition of electronic identification and trust services foreseen in the eIDAS regulation[77] facilitates cross-border access to digital services. Furthermore, the application of the Once Only Principle referred to in the e-Government Action Plan 2016-2020,[78] which is already included in the proposal for a Single Digital Gateway,[79] could reduce the administrative burden that students face when moving abroad.

In terms of certification, blockchain technology also appears as a new infrastructure to secure, share, and verify learning achievements[80]. A blockchain is a decentralized and distributed digital database that is used to record transactions in a secure and verifiable way. For certifications, a blockchain can keep a list of issuer and receiver of each certificate, together with the document signature (hash) in a public database (the blockchain) which is identically stored on thousands of computers around the world.[81]

Priority 2: Developing relevant digital competences and skills for the digital transformation

The digital revolution had, has, and will continue to have a wide impact on the way Europeans live, work and study. This revolution is fast-paced not only for the rapid technological developments but as

---

[73] European Commission. (2013). Study of the impact of eTwinning on participating pupils, teachers and schools. https://publications.europa.eu/en/publication-detail/-/publication/ec23d4e3-e305-4d1c-83da-1989d35ec7e0/language-en

[74] The eTwinning National Support Services and the Erasmus+ National Agencies.

[75] European Commission. (2013). Study of the impact of Comenius school partnerships on participating schools. https://publications.europa.eu/en/publication-detail/-/publication/ec8ce099-fec9-4563-a1ca-cd4db1b984ec/language-en

[76] Haywood and al. (2016). *Students mobility in a digital world*. https://www.coimbra-group.eu/victorious/VIC%20Final%20Report%20print%20version.pdf

[77] Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on electronic identification and trust services for electronic transactions in the internal market and repealing Directive 1999/93/EC.

[78] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. EU eGovernment Action Plan 2016-2020. Accelerating the digital transformation of government.

[79] The proposal for a Single Digital Gateway foresees the exchange of evidence for a limited number of digital public services, e.g. applying for a study grant from a public institution and requesting a change of address. See this proposal et http://europa.eu/rapid/press-release_IP-17-1086_en.htm and discussions on the "Once-Only Principle" https://ec.europa.eu/digital-single-market/en/news/eu-wide-digital-once-only-principle-citizens-and-businesses-policy-options-and-their-impacts

[80] European Commission. (2017). Blockchain in Education. JRC Science for Policy Report, European Commission, EUR 28778 EN. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC108255/jrc108255_blockchain_in_education(1).pdf

[81] Smolenski, N. (2016a). *Academic Credentials in an era of digital decentralisation*. Learning Machine Research.

well for the speed in which digital technologies are appropriated (or "domesticated")[82] by users. While it took 17 years for the television to reach 30% of US households, it took the Internet 7 years to reach the same penetration level.[83]

The use of technology is underpinned by digital competence. Digital competence is one of the eight Key competences for lifelong learning.[84] The European Digital Competence Framework for citizens lists and describes 21 competences clustered in five areas, namely: Information and data literacy; Communication and collaboration; Digital content creation; Safety; Problem solving. In a nutshell, being digitally competent requires being able to search for information and data and evaluate and judge it; being able to communicate and collaborate in various forms through digital means; being able to create, edit, and improve digital content in a variety of forms (from text to audio content to the ability to create computer programmes); keeping safe in the digital sphere and caring about the safety and well-being of others, of devices, and of the environment; being able to solve problems through digital means (from technical to conceptual ones) and to innovate through technologies.[85]

Living in a digital era and society calls for the need of all citizens to acquire and keep developing digital competence to keep abreast of technological developments and practices. Full participation in society requires a set of competences related to the ability to use digital technology: understood as "life skills", they are comparable to literacy and numeracy. Being digitally competent is nowadays both a requirement and a right. Indeed, the Council recently acknowledged that digital competence is (together with literacy and numeracy) crucial for accessing and progressing in the labour market and for engaging in further education and training, besides playing an active role in society.

Discourses on the digital divide evolved from a focus on access to a focus on competences. Access was the first criterion to explain the digital divide, a concept which came into use in the 90s to allude to the differences in digital inclusion. Participation in the digital domain depends increasingly more on knowledge, skills and attitudes (in short: competence) than on access to and use of digital technology. Differences in digital competence unequal the ability of citizens to seize the opportunities that are offered by digital technology and to avoid the risks that come with use.

Nowadays, digital technology is used by most people every day. In 2016, more than two thirds (71 %) of individuals in the EU-28 accessed the internet on a daily basis. If we consider the group of internet users (thus taking aside those who are totally digitally excluded), we realise that Internet use largely equals daily use: the proportion of daily users among internet users averaged 87 % in the EU28.[86] In certain countries, like Italy, the share of daily users is very similar to that of total users.[87] Uneven competences lead to discrepancies in how every citizen is exposed to threats. Currently, one in every four Europeans believes that their digital competence is insufficient for their daily lives.[88] According to the Digital Skills Index, 44% of the EU population has an insufficient level of digital skills, and 19% of the EU population has no digital skills.

---

[82] Roger Silverstone calls 'domestication' the process by which new technologies is 'tamed' or appropriated by its users, see Silverstone, Roger, Hirsch, Eric (Eds.) (1992). *Consuming Technologies: Media and information in domestic spaces*. London/New York: Routledge.
[83] Katz, J. E., & Rice, R. E. (2002). *Social consequences of Internet use: Access, involvement, and interaction*. MIT press.
[84] European Commission. (2016). *Recommendation on key competences for lifelong learning*. 2006/962/EC http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Ac11090
[85] European Commission (2017). *DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use*. JRC Science for Policy Report, EUR 28558 EN. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC106281/web-digcomp2.1pdf_(online).pdf
[86] European Commission. (2017). *The Digital Economy and Society Index* (DESI). https://ec.europa.eu/digital-single-market/en/desi
[87] OECD (2016). *Innovating Education and Educating for Innovation*. The Power of Digital Technologies and Skills. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264265097-en
[88] European Commission, (2017) *Special Eurobarometer 460: Attitudes towards the impact of digitisation and automation on daily life*. https://data.europa.eu/euodp/data/dataset/S2160_87_1_460_ENG

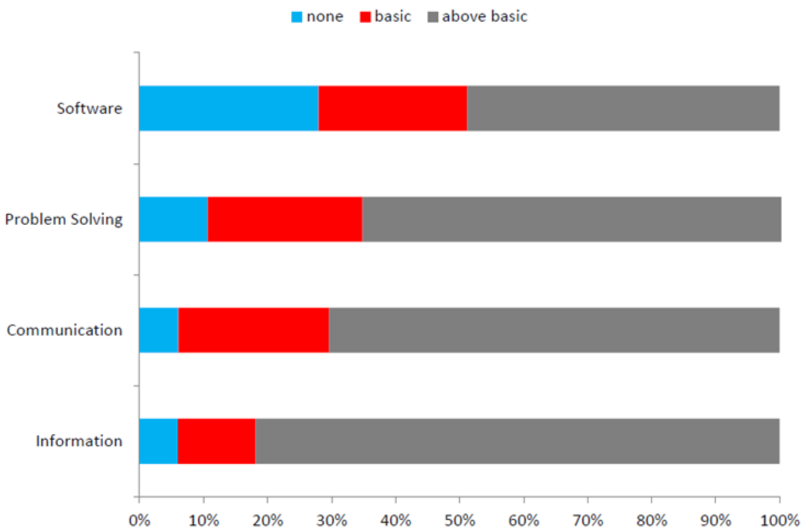
Statistics show that the most vulnerable segments of the population – the very young – are also the most avid internet users.[89] Households with dependent children are more likely to have access to a computer and the internet at home.[90] In the UK, 93% of all 5-15 year olds in the UK used the internet in 2013, with as many as four in five 5-7 year olds (82%). On average in Europe, children start using the Internet from the age of 7; between the age of 9 and 16, the average time they spend online amounts to 88 minutes per day.[91] According to recent studies on very young children (0-8 year olds), they seem to go online regardless of their level of digital competence, and regardless of their fluency (or lack thereof) in the use of digital technology.[92] Children, although conversant with technology, are not necessarily digitally savvy: the myth of digital natives is certainly an exaggeration and it "obscures children's need for support in developing digital skills".[93] Furthermore, young people with an economic or social disadvantage tend to have weaker digital competence.[94]

There are opportunities to be seized and risks to be avoided when making use of digital technology, and low level of digital competence has consequences on several aspects of daily life: 20 to 25 % of European adults aged 16 to 65 with low levels of proficiency in literacy, numeracy and problem-solving in technology-rich environments are less likely to take part in learning or to participate fully in the digitally driven economy and society.[95] The reliance on digital technology for everyday activities has consequences on the choices of citizens as consumers. There is a recognized need worldwide to educate citizens as critical consumers of internet services and electronic media, helping them to make informed choices[96]. The increasing sophistication of digital marketing practices calls for a new set of competences that citizens need to embrace in the digital marketplace, to make informed choices, to increase their welfare, to be able to weigh the benefits against the risks. Consumers' digital competences are outlined and described in the European Commission's digital competence framework for consumers.[97] The framework does not suggest that competences can replace regulations and legislation that protect consumers, as both aspects - enhancing competences and updating legislation - must go hand in hand in providing a safe purchasing and selling experience. The need for improved policy, law and action is made in the report "When Free isn't"[98], which makes a strong case for the need to protect children against unfair and damaging business practices online.

When it comes to the need of digital competence for the labour market, data shows an evident gap. Only a small share of the EU's internet users has advanced software skills. In 2016, 28% of European internet users had no software-related skills[99] (see Figure 4).

[89] Livigstone, S.: *EU kids online report* http://www.lse.ac.uk/media@lse/research/EUKidsOnline/Home.aspx
[90] Eurostat. (2015). *Being Young in Europe Today.* http://ec.europa.eu/eurostat/en/web/products-statistical-books/-/KS-05-14-031
[91] European Commission. (2017). *Creating a Better Internet for Kids* https://ec.europa.eu/digital-single-market/en/policies/better-internet-kids
[92] European Commission. (2015). *Young Children (0-8) and digital technology*. A qualitative exploratory study across seven countries. EUR– Scientific and Technical Research Reports. http://publications.jrc.ec.europa.eu/repository/handle/JRC93239
[93] Livingstone, S., Haddon, L., Görzig, A., & Ólafsson, K. (2011). *EU Kids Online II final report*. www.lse.ac.uk/EUKidsOnlineFinalReport
[94] European Commission. (2014). *The International Computer and Information Literacy Study (ICILS): Main findings and implications for education policies in Europe* http://ec.europa.eu/dgs/education_culture/repository/education/library/study/2014/ec-icils_en.pdf
[95] Council Recommendation of 19 December 2016 on Upskilling Pathways: New Opportunities for Adults (2016/C 484/01) http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOC_2016_484_R_0001.
[96] OECD (2015). Students, Computers and Learning: Making the Connection, PISA. Paris. OECD Publishing.
[97] European Commission. (2016). *The Digital Competence Framework for Consumers. http://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=57486*
[98] eNACSO (2016). *When Free isn't Business, Children and Internet* http://www.enacso.eu/wp-content/uploads/2015/12/free-isnt.pdf
[99] European Commission. (2017). *Europe's Digital Progress Report*, http://ec.europa.eu/newsroom/document.cfm?doc_id=44390

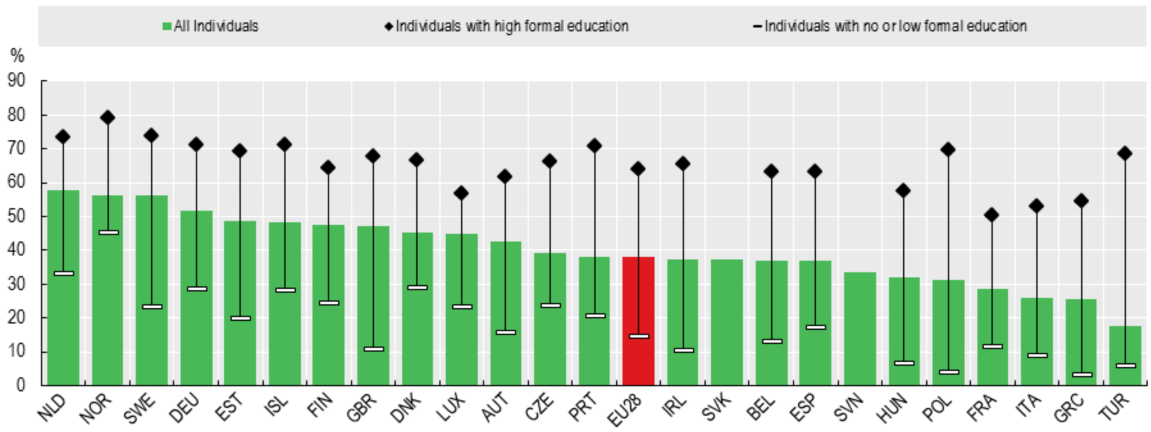
Figure 4: Digital skills by competence dimension and level, 2016 (% of internet users)



Source: Commission services based on Eurostat, European Commission, Europe's Digital Progress Report 2017. http://ec.europa.eu/newsroom/document.cfm?doc_id=44390

The lack of digital competence has a direct relevance to employability. In OECD countries, 42% of people with no digital competence are unemployed, and around 40% of people think that their computer skills are not sufficient to find a new job;[100] while at the same time 40% of the EU companies do not find appropriate candidates.[101] There is therefore a mismatch between offer and demand that has as a crucial turning point the level of digital competence of the population.

Figure 5: Individuals who judge their computer skills to be sufficient if they were to apply for a new job



Source: OECD, Measuring the digital economy, a new perspective, 2014. http://dx.doi.org/10.1787/888933148354

[100] OECD. (2014). *Measuring the digital economy, a new perspective.* Paris. OECD Publishing. http://dx.doi.org/10.1787/888933148354
[101] OECD and European Union (2015), *The Missing Entrepreneurs 2015*: *Policies for Self-Employment and Entrepreneurship.* Paris. OECD Publishing.

2.1. Providing a wide and deep digital education for all

Digital competence refers to the ability to be efficient, critical, and creative in a digital environment. The concept has been evolving since its appearance, going from a specialised competence in the 60s, relevant for computer scientists, to being a relatively widespread operational skill mainly for the workplace centred on the use of a limited amount of applications and specific software in the 80s. Nowadays, digital technology is used by almost everyone for almost any purpose and domain and the concept of digital competence widened.

Being digitally competent today requires having a wide set of knowledge, skills, and attitudes that touch upon several aspects of the digital domain, as illustrated in the European Digital Competence Framework for citizens which lists and describes 21 competences. These competences unroll into in 8 proficiency levels, from foundation to highly specialised.[102]

The teaching of digital competences is a common element of school education across Europe,[103] increasingly even from primary school age.[104] Already in 2012, almost all Member States had a national policy to develop digital competence in formal education. Moreover, in the majority of EU countries digital competence already had in 2012 a cross-curricular status, i.e. requiring teachers to adopt digital technology across the different curriculum subjects and promoting the development of digital competence alongside specific subject competences.[105] The recent study "All in the same boat"[106] reveals that digital competence is developed in formal education across Europe, very often from primary schools. However, there are rarely stand-alone curricula for teacher training in the matter, thus leading to the risk of a teaching workforce that might not have the appropriate and specific subject-matter knowledge. In this line, the recently published European digital competence framework for educators[107] describes the key components of educators' digital competence. Moreover, as digital competence is a wide domain, there is the underlying risk that its development might only be catered on some specific aspects (for instance: operational skills, as it was the case until very recently), thus leaving aside all the diversified knowledge, skills, and attitudes that students need to become empowered and safe digital citizens.

Recent curricular reforms in Europe spur from the need to include several aspects of digital competence in education and provide students with the ability to understand how computer works. In this wave, coding and computing are seen as providing children with the knowledge and skills they need to understand digital technology from a different perspective, by being able to create digital outputs rather than merely consume them. Although young people are avid consumers of technology, only 13% of young people have written a computer programme,[108] ranging from 2% in Romania to almost 30% in Denmark.

---

[102] European Commission. (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use, JRC Science for Policy Report, EUR 28558 EN. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC106281/web-digcomp2.1pdf_(online).pdf

[103] Balanskat, A. & Engelhardt, K. (2015). *Computing, our Future*. Brussels. European Schoolnet.

[104] European Commission, (2016), *Developing Computational Thinking in Compulsory Education* https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/developing-computational-thinking-compulsory-education-implications-policy-and-practice

[105] Eurydyce. (2012) *Developing Challenges and Opportunities for Policy Eurydice Report at School in Europe: Key Competences* http://eacea.ec.europa.eu/education/eurydice/documents/thematic_reports/145en.pdf

[106] Informatics Europe (2017) *Informatics Education in Europe: Are We All in the Same Boat?* http://www.informatics-europe.org/news/382-informatics-education-in-europe-are-we-on-the-same-boat.html

[107] European Commission (2017). *European Framework for the Digital Competence of Educators (DigCompEdu)*, JRC Science for Policy Report, EUR 28775 EN. https://ec.europa.eu/jrc/en/digcompedu

[108] Source: Eurostat, 2016.

From the curricular development side, an upsurge in the integration of computing in compulsory education is evident. Several countries underwent curricular reforms that addressed the inclusion in curricula of elements of computing since 2014.[109] In this recent wave of curricula reforms, at least eight European countries (DK, FR, FI, HR, IT, MT, PL, UK) have recently concluded a reform process that includes computation or coding. At least six others (CZ, GR, IE, NL, NO, SE) are planning to introduce computing or coding into compulsory education.[110]

Besides curricular reform, there is an array of initiatives that emerge in different educational settings at local, national and international levels with the aim to bring coding and computing to children. Initiatives arising outside formal education have been the first to fill the gap between the perceived need for computing and the lack of systemic educational provision.[111] These initiatives stem from the need of moving away from a digital consumer perspective and engage people (especially youth) in using technologies for creative, productive purposes. Among these initiatives at European level, notable ones are CoderDojo (Ireland);[112] Bebras (Lithuania);[113] and the EU Code Week.[114] The latter is a grassroots movement run by volunteers who promote coding in their countries as Code Week Ambassadors. The aim is to bring coding and digital literacy to everybody in a fun and engaging way. The Young Advisors of the Digital Agenda launched the initiative in 2013. Since then, participation in this initiative evolved as follows:

- in 2013: 10,000 people, 3,000 events in 26 countries;
- in 2014: 150,000 people, 4,200 events, 36 countries;
- in 2015: 580,000 people, 7,600 events, 46 countries;
- in 2016: 970,000 people, 20,000 events, +50 countries.

In 2017 Malta, Italy, Estonia and Poland had the most EU Code Week events per capita. In absolute numbers, Italy (+16,000) and Poland (2,400) had the most events with a high involvement of schools. Bringing this initiative to schools in other countries could enhance much wider participation and provide most children with equal opportunities in developing a specific aspect of digital competence.

As there is evidence of educational reforms that go "wide", i.e. addressing all aspects of digital competence, there is at the same time a need to go "deep", i.e. to explore specific aspects of digital competence. In other words, if all citizens (and students) need to acquire the wide set of digital competences, some of them will need to have the chance to develop into more advanced levels.

In formal education, there are at least six countries (AT, PT, CY, LT, HU, SK) with a long-standing tradition in Computer Science education, mainly in upper secondary schools.[115] Engaging students from secondary schools in advanced digital competence development is fundamental to be able to enlarge the cohort of youth who can undertake a specialised education in informatics and computer science at tertiary level, in order to respond to the current shortage of ICT specialists.

---

[109] Balanskat, A. & Engelhardt, K. (2015 & 2016). *Computing, our Future*. Brussels. European Schoolnet.

[110] European Commission. (2016). *Developing computational thinking in compulsory education - Implications for policy and practice*. JRC Science for Policy Report, EUR 28295 EN; doi:10.2791/792158. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/developing-computational-thinking-compulsory-education-implications-policy-and-practice

[111] European Commission (2016). *Developing computational thinking in compulsory education - Implications for policy and practice*. JRC Science for Policy Report, EUR 28295 EN; doi:10.2791/792158. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/developing-computational-thinking-compulsory-education-implications-policy-and-practice

[112] https://coderdojo.com

[113] Bebras: International Challenge on Informatics and Computational Thinking, http://bebras.org/

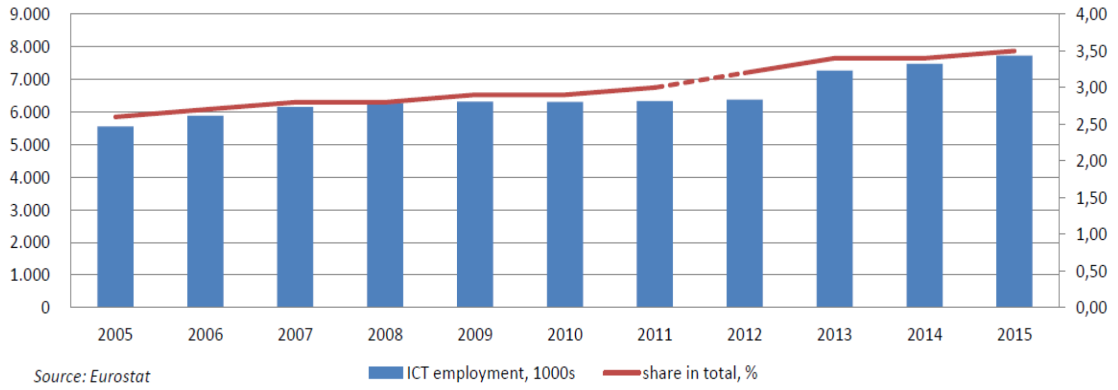
[114] www.codeweek.eu/

[115] European Commission (2016). *Developing computational thinking in compulsory education - Implications for policy and practice*. JRC Science for Policy Report, EUR 28295 EN; doi:10.2791/792158. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/developing-computational-thinking-compulsory-education-implications-policy-and-practice.

Between 2005 and 2015, employment of ICT specialists in the EU grew by 2.2 million to reach 7.7 million in 2015. This amounts to a 35% increase in the share of ICT jobs in total employment, from 2.6% to 3.5%. The compound annual growth rate over the same period stood at about 3% (allowing for breaks in the time series). This is to be compared to the much slower growth in total employment, which returned to pre-crisis levels only in 2014.

All EU Member States have seen an important increase in ICT specialist employment over the past decade (2005 to 2015). In absolute terms, the largest increases occurred in DE (659,000), FR (381,000), the UK (192,000) and IT (135,000). However, growth in ICT specialist employment has also been very substantial in many smaller countries. According to 2015 data, the Member States with the highest shares of ICT specialists in total employment are FI (6.5%), SE (6.1%), NL and the UK (both 5%). Despite the positive evolution in recent years, as shown in Figure 6, the gap between demand and supply of ICT specialists in the EU is expected to grow from 373 000 in 2015 to about 500,000 by 2020.[116] In other words, the employment potential of specialised ICT skills remains underexploited.

Figure 6: Employment of ICT specialists in the EU, in absolute terms ('000) and as share of total employment, 2005-2015



Source: Empirica (2017). Innovation leadership skills for the high-tech economy – Demand, supply and forecasting. High-Tech and leadership skills for Europe Conference – Brussels, 26th, January 2017

The constantly changing landscape of digital devices and software poses a particular challenge to education – from formal, to tertiary to VET and workplace. All kinds of skills can quickly be outdated and individuals will need to continuously develop their abilities further throughout life. Formal education can only lay the foundations by providing the fundamental digital competence that all learners require to engage with the dynamic digital world they live in.

2.2. Mitigating the negative effects of digital transformation

As citizens' life and data move online, all Europeans will encounter both the risks and opportunities that the digital transformation brings. Digital technology will continue to integrate further into our physical and mental activities and all generations will benefit from becoming confident digital citizens, empowered by the opportunities offered by digital technology, and at the same time aware of

[116] Empirica. (2017). *Innovation leadership skills for the high-tech economy – Demand, supply and forecasting. High-Tech and leadership skills for Europe Conference – Brussels*, 26th, January 2017.

and resilient to the side-effects of digitalisation. In particular, private data becomes more vulnerable in an online environment and individuals need to understand how to manage their online presence and keep accounts, information and devices safe. Although 'safety-by-design' and regulatory frameworks are envisaged and necessary, citizens are required to develop specific habits for a safer digital life, including password management, digital identity management, and awareness in the use of internet and devices.[117]

Beyond technical threats, the information and connections individuals encounter in the digital sphere can be harmful. Digital technology is misused for manipulation, radicalisation and brainwashing, including propaganda, political manipulation and even recruitment for terrorist purposes. The 'weaponisation' of social media for state-sponsored propaganda and interference in elections or national policy is today a reality.[118] False information ("fake news") and commercial, interest-group or politically driven misinformation is increasingly prevalent.[119] Information threats include trends such as 'post-truth' and 'alternative facts' that undermine the support for scientific analysis. Debunking false information,[120] legislation, and policing of manipulation are necessary but can usually occur after the fact.

The younger part of the population is the most exposed and yet the most vulnerable. One out of three Internet users is a child.[121] They go online at an ever younger age, using a diverse range of devices, and for various purposes: increasingly to search for information and to learn through different tools and services. Children aged 5-15 who use the internet spend more than 15 hours online in a typical week, with most children aged 12-15 have three or more media devices of their own. Around half of all 11 to 16 year-olds have encountered one or more of the most frequent internet risks. Only a minority of 8-15 years old can identify sponsored links in search engine results, despite their being distinguished by a green box with the word ‘Ad’ in it. With rapid technological developments, new risks emerge.[122] For example, internet connected toys can offer opportunities for playing, learning, health and educational support thanks to their interactive and personalised features, but they also raise questions about safety, security, privacy and trust.[123] The majority of parents whose child goes online tend to agree that the benefits of the internet outweigh the risks, however they are increasingly concerned about online risks such as cyberbullying, sharing personal details with strangers, exposure to content which encourages children to harm themselves, inappropriate online content and the possibility of their child to be radicalised online.[124]

The European Commission has been at the forefront in making the Internet a safer and better place for children. The European Strategy for a Better Internet for Children[125] sets out a series of actions for online safety, combining financial support, legislation and self-regulation, involving Member States, industry and civil society. Under this framework, the EC co-funds a pan-European network of Safer

---

[117] The Europol. (2017) *Internet Organised Crime Threat Assessment* provides an overview of common risks.

[118] Oxford Internet Institute. (2017) *Troops, Trolls and Troublemakers: A Global Inventory of Organized Social Media Manipulation* http://comprop.oii.ox.ac.uk/wp-content/uploads/sites/89/2017/07/Troops-Trolls-and-Troublemakers.pdf

[119] Oxford Internet Institute. (2017) *Computational Propaganda Worldwide: Executive Summary* Computational Propaganda Worldwide: Executive Summary http://comprop.oii.ox.ac.uk/wp-content/uploads/sites/89/2017/06/Casestudies-ExecutiveSummary.pdf

[120] Such as the European External Action Service's EU vs Disinformation campaign: https://euvsdisinfo.eu/about/

[121] Livingstone S., Carr, J. and Byrne, J. (2015) One in Three: Internet Governance, and Children’s Rights https://www.cigionline.org/publications/one-three-internet-governance-and-childrens-rights

[122] Ofcom. (2017). *Children and parents: media use and attitudes report https://www.ofcom.org.uk/research-and-data/media-literacy-research/childrens/children-parents-2017*

[123] European Commission. (2017). Kaleidoscope on the Internet of Toys: Safety, security, privacy and societal insights, JRC Technical Research, EUR 28397 EN. https://ec.europa.eu/jrc/en/publication/kaleidoscope-internet-toys-safety-security-privacy-and-societal-insights

124 Ofcom. (2017) *Children and parents: media use and attitudes report* https://www.ofcom.org.uk/research-and-data/media-literacy-research/childrens/children-parents-2017

[125] European Commission. (2012). *European Strategy for a Better Internet for Children*, https://ec.europa.eu/digital-single-market/en/european-strategy-deliver-better-internet-our-children

Internet Centres, coordinated at EU level by Insafe and INHOPE,[126] along with the core platform betterinternetforkids.eu as a single entry point for online tools and services for EU citizens and the Safer Internet community. The Centres deliver a range of awareness-ranging activities, including developing resources, hosting trainings and events for children and young people, and those that care for them, such as parents, carers, teachers, educators and other professionals in the children's workforce. In 2016, Safer Internet Centres reached over 3 million people through events and trainings. The Centres' helplines received more than 36,000 contacts connected to online issues such as cyberbullying and sextortion.[127] The European Commission's annual Safer Internet Day is now celebrated in over 130 countries on all continents. In 2016, more than 20 million EU citizens were reached through various events and activities.

Fake news is an increasing concern, and particular attention should be paid to protecting and empowering vulnerable groups of online users such as children. The proliferation of false information has been made possible by the velocity at which such news may spread, and the global reach they might attain through new channels, namely social media. Close to half of 12-15 years old who use these channels for news find it difficult to tell whether a story is true. A quarter of users aged 8-11 and 12-15 believe that if a website is listed by a search engine it can be trusted.[128]

Meanwhile, digital technology penetration is increasing. There will be 6 billion devices connected in the EU by 2020. Yet 51% of European citizens feel not at all or not well informed about cyber threats. 86% of Europeans believe that the risk of becoming a victim of cybercrime is increasing. This increase gives way to new risks and increase current vulnerabilities. The consultation to the Review of the 2006 Recommendation on Key Competences for Lifelong Learning carried out in 2017 yield interesting results. Respondents stressed that the digital competences citizens require include particular media and digital literacy. They believed that a focus on digital and media literacy is a way to respond to the digital risks, by ensuring that children are aware how to responsibly and safely use the internet and are empowered to become digital citizens.

2.3. Attracting more girls to study ICT through digital and entrepreneurship education

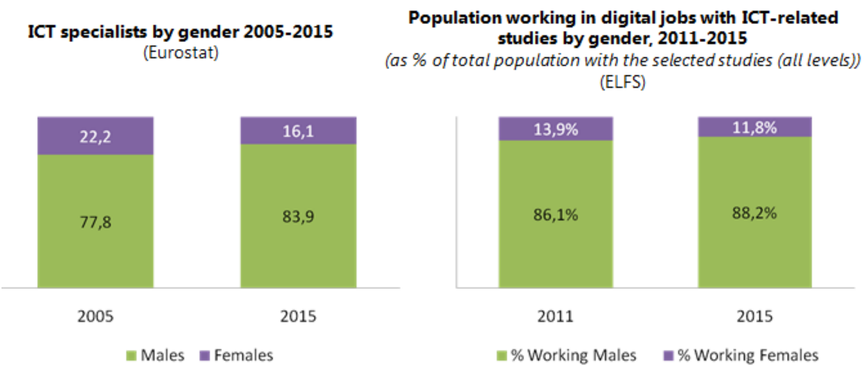
In the EU, women are underrepresented in ICT professions: less than one in five ICT professionals are female.[129] While both girls and boys have similar levels of interest and competence in digital technology, fewer girls go on to develop this interest for their studies or for a career. This phenomenon is the result of a number of factors which deter young women from the field already at a secondary school age. Several studies point towards the lack of information campaigns about the potential of a career in ICT as of primary importance. According to a research conducted in 2015 specifically focusing on the low number of females in cybersecurity, 77 percent of young women stated that neither a high school teacher nor guidance counsellor ever mentioned it as a potential career option.[130] Moreover, a survey conducted by PwC revealed that the two principal reasons why girls were put off ICT careers had to do with the fact that they didn't know what it involved and they didn't think they

[126] https://www.betterinternetforkids.eu/web/portal/policy/insafe-inhope
[127] Better Internet for Kids (2017), Annual Report https://www.betterinternetforkids.eu/bikannualreport2016-17/
[128] Ofcom. (2017) *Children and parents: media use and attitudes report* https://www.ofcom.org.uk/research-and-data/media-literacy-research/childrens/children-parents-2017
[129] 83.9% of employed ICT specialists are male, 16.1% female (Source: Eurostat, 2015).
[130] Cybersecurity Nexus. (2017). *State of Cyber Security 2017*. https://cybersecurity.isaca.org/state-of-cybersecurity

were creative enough to work in the field.[131] These factors, together with the perception of ICT as a male-dominated field result in many girls hesitant to engage with digital education at a higher level. Interest of girls is lost well before they make choices on university careers: the interest of girls in STEM subjects begins when they are between 11 and 12 but drops significantly when they are 15 or 16 years old,[132] right at the moment where critical study (and career) choices are about to be made.

There is also a large gender gap in Europe in the entrepreneurship, management and technology sector resulting from the fact that too few girls choose STEM disciplines and careers. Women constitute 52% of the European population. In 2015, women made up 13% of the graduates in ICT-related fields working in digital jobs compared to 15% in 2011. In 2005, 22% of European ICT specialists were women. In 2015, this has dropped to 16%.[133]

Figure 7: ICT specialists and jobs by gender



Moreover, women are still underrepresented among tech entrepreneurs in decision-making positions. When it comes to the tech sector, women make up only approximately 15% of tech-sector jobs in the European Union, and at senior management and company board levels their participation is even lower with a few exceptions in certain European countries. Although women are often early adopters of new technology, they are rarely at their inception. An example is that a mere 9% of European app developers are female. These figures make women the largest untapped entrepreneurial and leadership potential in Europe.

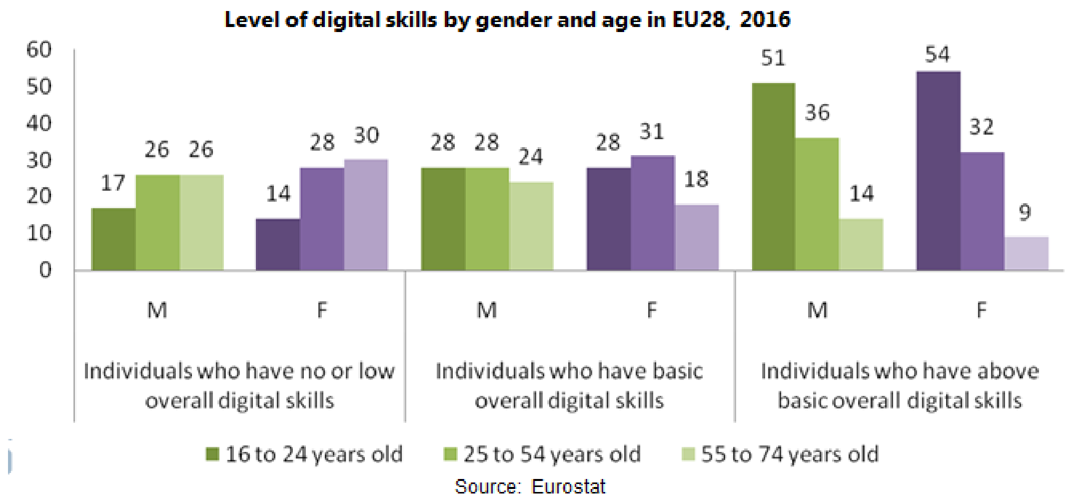
However, there is a huge potential to change these numbers once education is properly exploited. Education plays a crucial role in shaping the future (digital) entrepreneurs and economic leaders. Evidence shows that people can learn to be entrepreneurial and relevant skills and attitudes can be developed through education. In fact, pupils attending entrepreneurship education programmes are 50% more willing to create start-ups compared to students who did not receive such training. To overcome stereotypes, girls and young women require positive examples, role models and support to realise that digital might be the right career choice for them. Therefore, raising the share of female STEM and ICT students and active female ICT professionals can help unleash Europe's digital potential and ensure that women take an equal part in shaping the digital world.

[131] Frost and Sullivan. (2017). *The 2017 Global Information Security Workforce Study: Women in Cybersecurity.* https://iamcybersafe.org/wp-content/uploads/2017/03/WomensReport.pdf

[132] Microsoft. (2017) Why Europe's girls aren't studying STEM https://www.microsoft.com/empowering-countries/en-us/gender-equality/what-keeps-girls-from-pursuing-a-stem-career/

[133] European Commission. (forthcoming). *Women in Digital Age.* EC - SMART 2016 0025.

Figure 8: Level of Digital Skills by Gender and Age in EU28



2.4. Advanced digital competence for all sectors

Advanced digital competence is not only relevant for ICT professions. High-level digital competences are necessary in a variety of disciplines and jobs. Knowledge specialisation and differentiation has increased and will continue to increase.[134] This specialisation is driven equally by new technological developments and by a changing labour market that sees the obsolescence of old jobs and the creation of new ones, plus a shift towards the need to be digitally skilled in most if not all professions.

Regardless of the sector, digital technology is widely used in the workplace. The vast majority of European workplaces use desktop computers (93%), broadband technology to access the internet (94%), portable computers (75%) and other portable devices (63%). Much smaller proportions of workplaces use an intranet platform (22%), CNC (Computer numerical control) machine or tools (8%) or programmable robots (5%). Specific sector-based trends can be observed.

The proportion of workplaces requiring their employees to possess digital competence varies greatly according to the type of job and the type of digital competence. The demand for digital competence is clearly related to the job role of the worker, and the evidence gathered through the European Digital Skills Survey[135] indicates that in some job categories more than 90% of jobs require specific types of digital skills at least to a basic level. Advanced digital skills are mostly demanded for professionals (54% of workplaces), technicians (52%) and to a lesser extent clerical workers (45%), managers and building workers (31% of workplaces in both cases) who are required to have this type of digital skills, while they are considered much less important for all other occupations. Specialist digital skills are required mostly for workers employed as professionals and technicians (43% and 44% respectively),

[134] Muller, J. (2014) *The future of knowledge and skills in science and technology higher education* https://link.springer.com/article/10.1007/s10734-014-9842-x
[135] European Commission. (2017): *ICT for work: Digital skills in the workplace.* https://ec.europa.eu/digital-single-market/en/news/ict-work-digital-skills-workplace

and to a lesser extent as managers (33% of workplaces). Advanced and specialist digital skills are very much related to specific sectors (in particular manufacturing and information and communication) and are more likely to be required in larger workplaces.

15% of workplaces report the existence of digital skill gaps in their workforce, indicating that a proportion of their employees are not fully proficient in carrying out tasks involving the use of digital technologies. One third of workplaces with digital skills gaps express concern about the impact that gaps could have on the workplace performance (36%). The type of impact most frequently reported is a loss of productivity (46%) followed by an expected decrease in the number of customers (42%). Large workplaces, and workplaces in the manufacturing or construction sectors are more likely to report digital skill gaps. Overall, the density of the digital skills gap varies greatly according to the type of digital skills in relation to the different occupations, thus showing the trend of a need for specific digital skills that related to each sector. Larger digital skills gaps are more likely to be found in the high-skilled (managers, technicians) and in medium-skilled (clerical workers, sales workers) occupations, and to a lesser extent in the low-skilled occupations, with the exception of workers in elementary occupations. Skill gaps related to advanced digital skills are more concentrated among sales workers (18%), technicians (17%), plant machine operators (17%), clerical workers (16%) and elementary occupations (15%). Skills gaps related to specialist digital skills are more concentrated among sales workers (23%), followed by elementary occupations (18%) and technicians (16%).

Advanced digital skills are needed (and lacking) in tertiary education and research. This is evident in the current transition towards Open Science. Research nowadays can be carried out and disseminated via an open science approach, which entails a shift from publishing in proprietary journals to publishing on open access journals.[136] Open science, as per the Open Education Framework,[137] is part of the research dimension of open education and is about removing barriers to access to data and research outputs, and also about broadening participation in research.

This shift from proprietary to open publications is important because it means that research results can be shared to all. Open Science is about open access, but it also enables open research collaboration, open data and citizens' science.[138] This shift of practices from close to open can only take place if researchers become knowledgeable of how they can share their research results, not only in open access journals but also by open research practices which can become an intrinsic part of their day-to-day academic activities. This requires specialised and advanced digital skills to be developed in the frame of research. An open educator[139]/scientist implements openness along four main activities, such as: open learning and open research design; OER (open educational resources); co-creation of knowledge, collaboration and open publications; and implementation of open assessment practices such as peer-to-peer review and collaborative evaluation. Hence, training academic staff and research students to become open educators and open scientists becomes essential.[140] Open Science skills can be regrouped into four categories, namely:

---

[136] European Commission. (2017) *Open innovation, open science, open to the world (2017)* https://publications.europa.eu/en/publication-detail/-/publication/3213b335-1cbc-11e6-ba9a-01aa75ed71a1

[137] European Commission. (2016). *Opening up Education: A Support Framework for Higher Education Institutions (OpenEdu Framework)*. JRC Scientific and Technical Research Reports, J. EUR 27938. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101436/jrc101436.pdf

[138] European Commission (2016). *Opening up Education: A Support Framework for Higher Education Institutions (OpenEdu Framework)*. EUR 27938. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101436/jrc101436.pdf

[139] IRRODL. (2016) *In search for the Open Educator: Proposal of a definition and framework to increase openness adoption among university educators* http://www.irrodl.org/index.php/irrodl/article/view/2736/3941

[140] European Commission. (2017). *Going Open: Policy Recommendations on Open Education in Europe*, JRC Science for Policy Report. https://ec.europa.eu/jrc/en/open-education

- Skills and expertise necessary for open access publishing;
- Skills and expertise regarding research data, data production, management, analysis/use/reuse, dissemination and a change of paradigm from "protected data by default" to "open data by default", respecting legal, and other constraints;
- Skills and expertise to act in and beyond one's own scholarly and disciplinary community;
- Skills and expertise resulting from a general and broad concept of citizen science, where researchers interact with the general public to enhance the impact of science and research.[141]

At least two out of four of those skills require a highly specialised proficiency in digital competence.

Priority 3: Improving education through better data analysis and foresight

Good policy making requires a solid base of evidence and well-developed predictions to inform and guide policy decisions and implementation. Stakeholders consulted for the Communication that this SWD supports[142] stressed that a better quality and more prolific data at EU level could support EU and national work. As digital change in education is accelerating, foresight work and an improved use of data to understand the status quo and progress over time can allow for informed, timely and responsive decision making.

Digital technology is increasingly used both for teaching and learning and for administrative processes, reporting and management. This implies that a large amount of data is for the first time collected or aggregated in a digital format and can be used to inform policy. Data analytics at institutional, regional and national level can help to predict issues and prepare interventions or targeted support. A wealth of data is already available: both sectoral data, such as the one collected for educational purposes, and general data, such as figures on populations, individuals' life pathways, or societal and economic trends. The latest is already available in structured national or European datasets[143] but not yet harnessed for the benefits of education. There is moreover a third typology of data that is available in uncollated forms that could be analysed to provide useful insights – such as data on labour market skills needs that can be identified through online job vacancies.[144] This point was developed in the New Skills Agenda, highlighting the need for sound evidence of the skills which will be required in the future to support policy-making, investments and reforms.[145]

Data needs to be collected and more importantly, analysed, used, and shared with care: the use of administrative or individual data can be perceived as intrusive or a violation of trust, and can set wrong incentives for both reporting and educational interventions.[146] Data can also easily be misunderstood or misconstrued, where for example simple indicators are misinterpreted as reflecting broader institutional performance or used to rank individuals or institutions.[147] At individual and institutional level, data can improve decision making and reveal hidden trends (for instance, predict drop-out) and enable early interventions. Increasing data collection at institutional level can also lead to better real-time data at national or regional level, which then allows for more timely and targeted

[141] https://ec.europa.eu/research/openscience/pdf/os_skills_wgreport_final.pdf
[142] Future of Learning Stakeholder Meeting, 23 October 2017.
[143] Such as the European Open Data Portal: https://data.europa.eu/euodp/data/
[144] Cedefop. (2016). *Using labour market information - Guide to anticipating and matching skills and jobs* VOLUME 1.
[145] European Commission. (2016). A new Skills Agenda for Europe, COM/2016/0381 final. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016DC0381
[146] *Key Messages on Learning Analytics* by the ET2020 Working Group on Digital Skills and Competences, October 2016: https://ec.europa.eu/education/sites/education/files/2016-pla-learning-analytics_en.pdf
[147] Policy & Policy Recommendations for Learning Analytics – A literature survey (STELA project, 2016) ; Policy recommendations for Learning Analytics from Three Stakeholder Workshops (LACE Project, 2015)

interventions.[148] At policy level an improved data flow can help understand current and future needs – e.g. trends in educational technologies or labour market needs – and help policy to develop timely responses. At the same time, data collection and analysis need to take into account data protection and privacy concerns.

Comparative data at EU level helps motivate change across Member States, identify the impact of specific policies, and promote good practices across borders. Foresight at EU level can be particularly beneficial to support Member States. It can draw on a larger evidence base and provide a more birds-eye and forward-looking perspective. Moreover, a EU-wide take on foresight in education allows to overcome the limits and constraints of a single national education system. This of course does not preclude the need for foresight work at national level.

As of today, there is a relatively small body of prospective work focussed on what will happen to education on the medium or long term. Moreover, there is a prevalence of a US-centred perspective, notably with the New Horizon Report series.[149] There appears to be a lack of prospective work in education and training in particular in the Central and Eastern and South European countries.[150]

3.1. Improving comparative data on digital education

Launched in 2009, the strategic framework for European cooperation in education and training (ET 2020) covers seven targets for 2020, in the fields of early leaving from education and training; tertiary education attainment; early childhood education and care; employment rate of recent graduates; low achievement in reading, mathematics and science; and learning mobility. The benchmarks are monitored based on data from the EU Labour Force Survey, UNESCO-OECD-Eurostat (UOE) joint data collection and the OECD's Programme for International Student Assessment (PISA). A number of data sources, studies, international surveys, and secondary analyses, also provide snapshot information or are used to monitor progress in additional priority areas currently not covered by targets, such as languages, adults' skills, migration, teachers, investment in education and training, ICT in education, entrepreneurship in education and VET.

Cross-European data evidence underpinning policy concerns is however not always easy to find, or readily available. For instance, a surge in migration and refugees in the last years highlighted the need for better, richer and more current data on migrants and refugees to allow for active measures to respond to the number of newcomers to education.[151] Fine-grained data on locations of individuals is normally available through national registers, but its use for educational planning might in many cases either not be possible or not be done for administrative, logistic or legal reasons. Better data provision and analysis can help identify the challenges faced by individuals, institutions, and education systems and propose possible solutions.

A long term perspective allows to yield returns on education policy interventions. Short policy cycles and changes in government priorities can lead to policy initiatives to be discontinued or to the resources required to support them being reduced, thus undermining the impact of the interventions. The long-term vision in education policy can be complemented by short-term achievable goals. The

---

[148] European Commission. (2016). *Research Evidence on the Use of Learning Analytics: Implications for Education Policy.*
[149] www.nmc.org
[150] *Support to a network of experts in prospective analysis in education* (ICF Consulting Services report for the European Commission, 2016 (unpublished)
[151] Estimates of the German Kultusministerkonferenz indicated that out of 800.000 refugees reaching Germany, 325.000 new school-age children had to be integrated in the education system in the course of 2015 https://www.kmk.org/aktuelles/artikelansicht/kultusministerkonferenz-mit-bildung-gelingt-integration.html

accomplishment of these goals should be integrated in an evaluation framework defined at the start of the policy. This allows for concrete results and achievements to be demonstrated to decision-makers and the public to determine funding and policy priorities. In addition, early consideration of sustainability, e.g. in the form of a sustainability plan, can increase the chances of policies having a long-term impact.[152]

A number of scoreboards such as the Digital Economy and Society Index (DESI)[153] or Eurostat statistics are providing regular data on the progress in Basic Digital Skills, the number of STEM graduates, or the use of computers for educational purposes. These indicators however do not provide deeper insights into the different approaches or the impact of digital technology on the learning experience and learning outcomes. There are indications, for instance, that the use of digital technology for some purposes and with some intensity can help students' learning outcomes, in particular those students from low socio-economic background.[154]

Both the role that digital technologies can play in education, as well as the need for all students to develop digital competences to thrive in today's world, are increasingly evident. However progress on digital education, while of high interest to both national and EU level policy, is not collected in a coherent and comparable manner. Such data can demonstrate where progress has been made – indicating e.g. success and failure of funding programmes – where action is needed and what kind of action is likely to bring the highest pay-off.

The *Survey of Schools: ICT in Education*, the last in-depth analysis of the uptake of technology in classrooms across Europe, is based on data collected in late 2011[155]. This analysis was based on over 190,000 responses from students, teachers and head teachers collected and analysed during the school year 2011-12. It provided detailed and reliable benchmarking on the use of information and communication technologies (ICT) in school education across Europe, from infrastructure provision to use, confidence and attitudes. The study provided valuable insights, such as the proportion of 'highly digitally-equipped' schools, the proportion of students in a given school year who had never or almost never used a computer in their school lessons, or the correlation between frequency of ICT-based learning activities students took part in during class, and the schools' formal policies on ICT use. Work to update this data through a new survey has started and results will be published in 2018. However, more needs to be done to ensure that data collection on digital technologies in education is improved and in particular that data is collected in a sustainable and continuous way in all educational sectors.

PISA data is a fix point of educational policy across the EU, as well as globally, and the basis for a large number of studies analysing the impact of various policies and classroom activities and their link to learning outcomes. In 2015 over half a million 15-year-olds in 72 countries, including all EU countries, took the PISA test. Drawing on this scaled approach, a dedicated ICT module, developed with the support of the European Commission, will ensure that a new and deep dataset becomes available, indicating how technology impacts learning outcomes across the globe. This will enable new kinds of comparative research to evaluate and provide feedback for policy making across the globe.

---

[152] European Commission. (forthcoming). Digital Education Policies in Europe and Beyond. A Discussion of exemplary cases, JRC Science for Policy Report.

[153] http://digital-agenda-data.eu/datasets/desi/indicators#desi-dimensions

[154] European Commission. (2017). Digital technologies and learning outcomes of students from low socio-economic background: An Analysis of PISA 2015. JRC Science for Policy Report. EUR 28688 EN. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/digital-technologies-and-learning-outcomes-students-low-socio-economic-background-analysis

[155] https://ec.europa.eu/digital-single-market/news/survey-schools-ict-education

3.2. Learning analytics and (Big) Data for Education

Initiatives on data use in education should be differentiated into two key parts, work towards *learning analytics* that aims to improve educational practice in teaching and learning, and the use of *(Big) Data for education*, which aims to generate insights for policy and decision making or serves to identify good practices. Many initiatives using technology in education are not evaluated in a way that also takes account of the results of other initiatives and available data. Therefore, little is known about which practices work and which are more efficient for different groups and education systems.

Using big data generated from digital platforms can help understand user behaviour and find evidence on how to leverage innovation in education. Data, if interpreted and used correctly, can provide valuable insights. For instance, an analysis of anonymised data of the eTwinning teacher network provided inspiring information on the possible development of teachers' network and on the needs and challenges of the teaching profession.[156] Big data in education, however, also causes issues related to data protection and privacy, especially when the question is about the data of children[157]. For instance, the American "inBloom" project, with a funding over $100 Million, had to be wound down after protests from parents and teachers about what they perceived to be intrusive data collection and analysis.[158]

Member States' taskforces hold a key position for legal experts to exchange with educators, technical experts and other stakeholders to identify the role that technologies such as Learning Analytics and Artificial Intelligence can play in education, while data protection, privacy and possibly wrong incentives arising from data use or publication are properly considered. For example, the French *Commission nationale de l'informatique et des libertés* (CNIL)'s Innovation, Studies and Foresight Department (PIEP) & Labs conducts regular meetings with stakeholders such as universities and the French Ministry of Education to provide advice on current investigations and experimentations. Similarly, the Finnish Ministry of Education organises a task force on Learning Analytics which also involves industry actors, as well as researchers, to help identify relevant issues and solutions for policy and interoperability.

Most current data sources used for monitoring the educational system and to generate insights for policy are focused on longitudinal studies, relying mostly on comparisons between time periods. While showing change over time, and across geographical units, such sources do not provide clear insights into the rate of change. They can moreover suffer from a 'collection to publication lag', from collection to publication. Published data thus relate to the past, but as it 'ages' through time, it often has residual authority well beyond its 'temporal decay': it is the 'latest available' data and is often used as a key reference. An example is the above-mentioned 2013 *Survey of Schools: ICT in Education*, based on data collected in late 2011. Results from this survey are as of today the most current evidence on a number of indicators of ICT availability and use in schools at both EU and in many cases national level.[159] As such, it still provides a valuable perspective and has been used for further analysis. For instance, a 2016 study estimated the current provision of internet connectivity in European schools from this basis and by comparison with smaller available datasets.[160] However, it is

[156] Vuorikari, R., Garoia, V., Punie, Y., Cachia, R., Sloep, P. (2012). *Teacher Networks*. Brussels. European Schoolnet. http://service.eun.org/teachers-newsletter/TellNet_Teacher_Networks_web.pdf

[157] European Commission (2016). *Research Evidence on the Use of Learning Analytics: Implications for Education Policy*, JRC Science for Policy Report, EUR 28294 EN. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/research-evidence-use-learning-analytics-implications-education-policy

[158] *The Legacy of inBloom*, Working Paper (Data & Society, 2017) https://datasociety.net/pubs/ecl/InBloom_feb_2017.pdf

[159] https://ec.europa.eu/digital-single-market/en/news/ict-education-essie-survey-smart-20100039

[160] European Commission. (2017). *Satellite broadband for schools: Feasibility study.* doi:10.2759/835661.

also known that current trends and changes in education, both at the level of policies and practices, are changing the educational landscape, thus resulting in these results to be outdated.

This presents challenges as the governance of education systems becomes more complex, and as more actors and stakeholders (students, teachers and administrators, politicians, interest groups, researchers etc.) are involved. Big data analysis can be an important contributor to improve the evidence for policy making, as data generated in real time can be rapidly aggregated for monitoring or focused analysis of problems, successful approaches or other insights at education system level.[161]

Learning analytics can help improve learning and is expected to trigger profound changes in assessment procedures and approaches. However the technology is still being developed and tested. Learning analytics of data logs is in the focus of much of the educational research.[162] The Learning Analytics Community Exchange (LACE) project generated valuable insights on the use of Learning Analytics in class, analysing the take-up of learning analytics across Europe and ethical concerns, and demonstrating that learning analytics can improve learning outcomes and improve learning support and teaching.[163] Comprehensive learning management systems have possibilities to generate amounts of both structured and unstructured data, which can be combined to get a more accurate view of a student's learning process, performance and achievements. [164] Ethical aspects are to be considered when using big data and learning analytics.[165]

As an emerging trend, big data analytics require more policy-oriented research, to identify risks and challenges. There are issues that should be addressed when dealing with big data, namely: storage, management, and processing. Using big data for purposes of educational assessment raises ethical and morals concerns: the ownership of the mixture of data collected from different sources could be a problem. Another question for the sector is how learning analytics will affect pedagogy and didactics. The impact of technological advancements linked to learning analytics and big data on pedagogy and teaching practices remains to be seen.

The way technologies are used in education reflects the structures and constrains, including social perspectives, through which they are created.[166] More comprehensive research is needed to address this link and identify the impact of data use on educational attitudes, processes and pedagogy. The current evidence shows for instance that automatic feedback to students that includes comparisons to peers can push students to improve their responsibility for learning and academic performance.[167] Data

---

[161] European Commission. (2017). *Big data for monitoring educational systems* https://publications.europa.eu/en/publication-detail/-/publication/94cb5fc8-473e-11e7-aea8-01aa75ed71a1

[162] Bienkowski, M., Feng, M., & Means, B. (2012). Enhancing teaching and learning through educational data mining and learning analytics: An issue brief. Washington, DC: Office on Educational Technology, U.S. Department of Education; DiCerbo, K. E., & Behrens, J. T. (2014). Impacts of the digital ocean on education. London: Pearson; Knight, S., Shum, S. B., & Littleton, K. (2013). Epistemology, pedagogy, assessment and learning analytics. In Third conference on Learning Analytics and Knowledge (LAK 2013) (pp. 75–84). Leuven: ACM; Mislevy, R. J., Behrens, J. T., Dicerbo, K. E., & Levy, R. (2012). Design and discovery in educational assessment: Evidence-centered design, psychometrics, and educational data mining. Journal of Educational Data Mining, 4, 11–48; Pereira, H. A., De Souza, A. F., & De Menezes, C. S. (2016). A computional architecture for learning analytics in game-based learning. Conference paper. 2016 IEEE 16th Conference on Advanced Learning Technologies; Rowe, E., Asbell-Clarke, J., Baker, R. S., Eagle, M., Hicks, A. G., Barnes, T. M., Brown, R. A., & Edwards, T. (2017). Assessing implicit science learning in digital games. Computers in Human Behavior, 76, 617–630; Siemens, G., & Baker, R. S. D. J. (2013). Learning analytics and educational data mining: towards communication and collaboration. In Second Conference on Learning Analytics and Knowledge (LAK 2012) (pp. 252 – 254). Vancouver, BC: ACM.

[163] http://evidence.laceproject.eu/

[164] Cope, B., & Kalantzis, M. (2015). Sources of evidence-of-learning: Learning and assessment in the era of big data. *Open Review of Educational Research*, Vol. 2, No. 1, 194–217.

[165] European Commission. (2017). Big data for monitoring educational systems https://publications.europa.eu/en/publication-detail/-/publication/94cb5fc8-473e-11e7-aea8-01aa75ed71a1

[166] Cope, B., & Kalantzis, M. (2015). Assessment and pedagogy in the era of machine-mediated learning. In T. Dragonas, K. J. Gergen, S. McNamee, & E. Tseliou (Eds.), Education as social construction. Contributions to theory, research and practice (pp. 350–374). Chagrin Falls, OH: Taos Institute Publications.

[167] Fritz, J. L. (2016). Using analytics to encourage student responsibility for learning and identify course designs that help (Ph.D.). University of Maryland, Baltimore County, United States — Maryland. http://umbc.box.com/johnfritzdissertation

analysis based on student writing is one of many examples illustrating the range and complexity of data sources that can provide insights on learning and performance across a range of disciplines.

Learning analytics can support game-based learning and apply techniques to detect "implicit learning", for instance to support Physics teaching.[168] Such analysis can also provide insights on less tangible elements, such as the behaviour and emotions of the players or learners.[169]

Successful use of learning analytics and big data analysis for education requires however more than just data and algorithms. Visualisation tools and training for educators and policy makers on how to – correctly and carefully – interpret data are equally important.[170]

3.3. User-driven innovation in tackling educational challenges

Innovation is an ongoing process in education. Despite a frequently portrayed image of education as inherently conservative or resistant to change, educators, schools, actors are largely innovating and furthering change to respond both to a new technological landscape and new demands regarding teaching and learning.[171] Education systems cover a large scale of individuals, organisations, and institutions – there are for instance around 2 Million teachers[172] and more than 20 Million students in school education in the European Union. Systemic change that reaches all of education can be slow. Education also has a responsibility to ensure that students receive similar opportunities and possibilities and no one is left behind. Accordingly, curricula and teaching methods tend to be changed progressively, rather than radically. Reforms require the involvement of several stakeholders and generally allow time for the participation of several educational actors.

The role of technology can be particularly contentious: as technological innovations often stem from non-education contexts, their penetration in education is sometimes hindered by resilience to change. In particular, the commercial element is considered, such as a lock-in of data and educational content in specific platforms, vendor control or marketing over software and devices, misuse of learner data or the involvement of vendors in teacher training or lesson design.[173] It takes time for technologies to be adapted to educational practices and for pedagogical approaches to be developed.[174] Technological, pedagogical, and policy solutions that directly address the needs of students and staff can however find quick uptake and are often shared within peer networks in education.[175]

Ensuring that good practices are developed and scaled requires listening to educators' and other stakeholders' experiences, challenges and views, so that the technical, pedagogical or policy solutions respond to the needs and experiences of practitioners on the ground. A co-design and exchange where solutions and pedagogical uses are developed in parallel can lead to especially good results. It is not surprising that several of the most used learning management systems and other educational solutions

[168] Rowe, E., Asbell-Clarke, J., Baker, R. S., Eagle, M., Hicks, A. G., Barnes, T. M., Brown, R. A., & Edwards, T. (2017). Assessing implicit science learning in digital games. *Computers in Human Behavior*, 76, 617–630.

[169] Hawlitschek, A., & Köppen, V. (2014). Analyzing player behavior in digital game-based learning: Advantages and challenges. In Busch, C. (Ed.), Proceedings of 8th European conference on games based learning ECGBL2014 (p. 199). Academic Conferences and Publishing International, 199 https://pdfs.semanticscholar.org/9090/044c7f186ca66e2a589186ef68f180c2110a.pdf

[170] Policy recommendations for learning analytics from three stakeholder workshops (Learning Analytics Community Exchange (LACE), 2015)

[171] OECD. (2016). *Innovating Education and Educating for Innovation: The Power of Digital Technologies and Skills*. Paris. OECD Publishing.

[172] http://ec.europa.eu/eurostat/statistics-explained/index.php/Secondary_education_statistics

[173] *Key messages on Working in partnership to tackle the digital skills gap* (ET2020 Working Group on Digital Skills and Competences, 2017)

[174] A common theme of the key messages of the ET2020 Working Group on Digital Skills and Competences, e.g. https://ec.europa.eu/education/sites/education/files/2016-pla-bring-your-own-device_en.pdf and https://ec.europa.eu/education/sites/education/files/201708-mobile-learning_en.pdf

[175] eTwinning is one such network allowing cross-European collaboration and exchange

are free and open source software, which allow for contributions and feedback from all stakeholders and have been taken up despite competing software offers promoted through large marketing campaigns.[176]

Ensuring participation and involvement of educators in the decision and design process can also counter a frustration among teachers who feel their voices, views and experiences are not always heard and considered.[177] In other sectors, hackathon-like approaches have had significant impact and generated both policy and technical solutions that responded directly to the needs identified by experts on the ground. The *Climathon*, an annual event organised since 2015 by the European Institute of Innovation and Technology's KIC InnoEnergy,[178] has each year focused attention and action on climate issues, created an active community, and generated practical technical and policy solutions to important challenges.[179]

Applying this model to education can allow educators, learners, and other educational stakeholders to both raise challenges and suggest solutions. It can moreover help to steer policy level actions and technical development towards improving digital education.

3.4. Foresight: from lagging behind to anticipating change

Foresight is a discipline that offers a structured approach to develop an understanding of likely developments in the mid-to long-term future. It aims to identify potential pathways and identifies choices and preparatory work required to ensure successful uptake in the future. It involves the broadest possible range of stakeholders to develop an understanding of the likely future ('future intelligence') and the challenges and opportunities this future and the transition process towards it will represent.[180] It is a versatile process that combines tested forward-looking methodologies to provide a context in which present assumptions and established paradigms can be challenged in an exploratory manner.

Foresight in Education is an already explored tool that allows the construction of shared visions. Anticipation is another valuable feature of this policy-planning method. Rather than to formulate policy reactions to technological innovations once their effects reach educational environments, both educators and policy proactively prepare for technological change before wide uptake.[181] Technology foresight provides a forum where key actors and stakeholders can collaboratively explore the dynamics of technological change and, most importantly, think about how they can act to affect desired change. Thus, the purpose of technology foresight is twofold: to produce outcomes that describe upcoming changes and trends, and to inspire whole communities to pursue certain types of change.

Change is not always linear. Accordingly, foresight on technology predicts the next steps of on-going technological developments, while at the same time considering societal responses. In other words, forecasting change has a technological dimension, that looks into new devices and tools that are going to be available in the market in the near future; and a societal dimension, that considers practices and changes that happen within society. These changes can be related to the penetration of technology or

---

[176] Such as Moodle (http://moodle.org/), Anki (http://ankisrs.net/), or Scratch (https://scratch.mit.edu/)
[177] Listen to Us: Teacher Views and Voices (Centre on Education Policy, 2016)
[178] https://climathon.climate-kic.org
[179] https://climathon.climate-kic.org/images/downloadables/Climathonbrochure.pdf
[180] The Commission's Futurium project is one example of general foresight https://ec.europa.eu/futurium/en
[181] Thayer (2014).Constructing Optimal Futures for Education - Technology Foresight in Educational Policy and Planning. *Nordic Journal of Digital Literacy* 02 / 2014 (Volum 9) https://www.idunn.no/dk/2014/02/constructing_optimal_futuresfor_education_-_technology_for

rather come from new behavioural patterns or shifts in norms and values. In education, this implies, for instance, that students, educators, parents and other educational stakeholders might, for various reasons, embrace or reject new digital technologies, or it might refer to the adoption of new pedagogies, or in shifting priorities for the education sector.

The use of foresight in education has been justified in several ways. First, with the widespread argument that educational organisation are slow in adopting technological change, second, with the hypothesis that young people who grew up with digital technology learn differently; third, as the change of technology is exponential, education will increasingly be lagging behind; fourth, the remit of education to prepare young people for the future.[182] Participative and predictive approaches can help look beyond current technological paradigms and, thus, build the capacity to inspire and motivate key players to consider implications and applications of existing and emerging technologies, and moreover to proactively pursue new pathways towards preferred future possibilities.

The ultimate goal of foresight is to help stakeholders and policy makers decide what they want educational environments to look like in the medium to long-term future. This knowledge and understanding will allow them to take steps to reach this prospective image of the likely or envisageable future. A notable example of foresight in the domain of education is the New Horizon Report series[183]. Since 2002, NMC Horizon Project from the New Media Consortium identifies and describes emerging technologies likely to have a large impact on education around the globe with a five years horizon. In 2014, the New Media Consortium and the European Commission cooperated in a study that specifically focused on the prospective impact of technologies on schools in Europe. The NMC Horizon Report Europe: 2014 Schools Edition[184], examined six key trends, six significant challenges and six important developments in educational technology that were very likely to impact educational change processes in European schools between 2014 and 2018. The experts participating in the study agreed on two imminent trends: the changing role of schoolteachers as a result of ICT influence, and the impact of social media platforms on learning. A more recent special report, "The Future of Learning", published as a supplement in The Times, describes three upcoming trends: skills mismatch, re-skilling, and robotics. More specifically, it investigates how to combat the skills crisis with lifelong learning programmes, why companies should upskill employees and how robots can teach workers new skills.[185]

The identification of trends and their analysis is the first step in speculation and prediction, and provides the basis for strategic planning and for policy making to anticipate change, thus enabling educational policies to lead innovation rather than lagging behind.

---

[182] Thayer. (2014).Constructing Optimal Futures for Education - Technology Foresight in Educational Policy and Planning. *Nordic Journal of Digital Literacy* 02 / 2014 (Volum 9) https://www.idunn.no/dk/2014/02/constructing_optimal_futuresfor_education_-_technology_for

[183] https://www.nmc.org/nmc-horizon/

[184] European Commission & The New Media Consortium. (2014). *Horizon Report Europe: 2014 Schools Edition*, EUR 26673 EN. https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/horizon-report-europe-2014-schools-edition

[185] Raconteur. (2017). The future of learning, supplement of The Times, September 2017. https://www.raconteur.net/future-learning-2017