



STRATEGIES TO ADDRESS THE DIGITAL SKILLS GAP IN THE EU | *April 2022*



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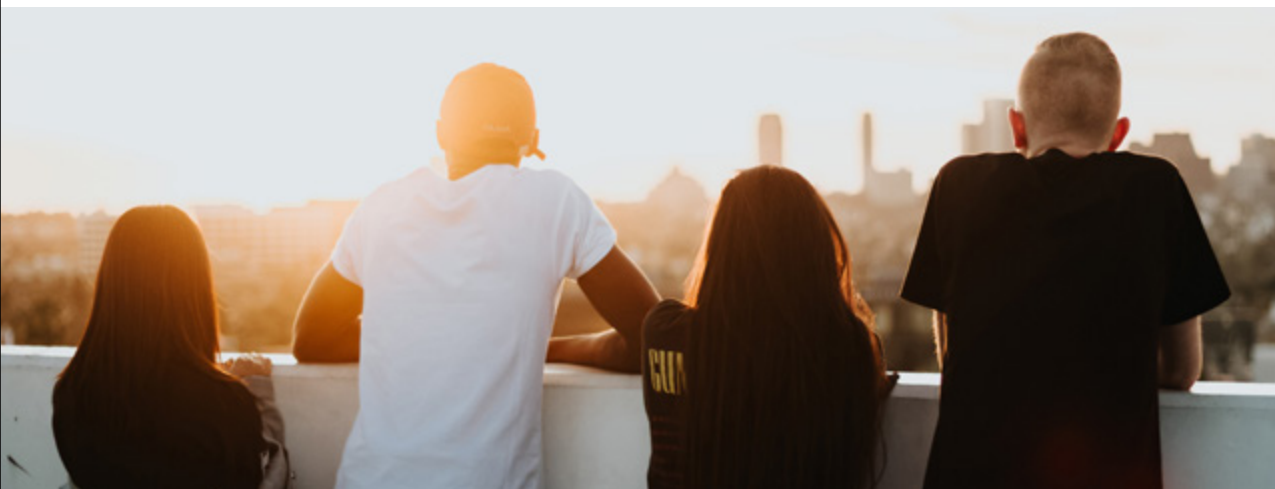
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List of abbreviations

CEDEFOP	European Centre for the Development of Vocational Training
DESI	Digital Economy and Society Index
DIH	Digital Innovation Hub
DRIVES	The Development and Research on Innovative Vocational Educational Skills
EIB	European Investment Bank
EC	European Commission
ENQA	European Association for Quality Assurance in Higher Education
EPSRA	European Pillar of Social Rights Action
ESG	European Higher Education Area
EU	European Union
EU-27	27 Member States of the European Union (from 2020)
EU-28	28 Member States of the European Union (2013-2020)
GDP	Growth Domestic Product
I4MS	ICT Innovation for Manufacturing SMEs
ICT	Information and Communication Technologies
ILO	International Labour Organization
IoT	Internet Of Things
ISCED	International Standard Classification of Education
IT	Information Technology
JRC	Joint Research Centre
MS	Member State
OECD	Organisation for Economic Cooperation and Development
SME	Small and Medium-sized Enterprises
STEM	Science, Technology, Engineering and Mathematics
VET	Vocational Education and Training

Executive Summary



The EU is undergoing a dual digital-green transition, yet it continues to experience significant gaps in ICT specialists and adequate re/up-skilling in digital skills for ICT professionals, the overall workforce and the general population. In this context, Huawei and All Digital, have collaborated with the support from EY Advisory, in combining analysis of existing data with original insight from primary sources in order to i) investigate the key elements that characterise the digital skills gap in the EU, ii) report the main challenges faced by industry, and the existing policy and industry responses, iii) identify possible areas where relevant stakeholders can play a role in the next decade. The analysis encompasses the EU-27, with a deeper focus on the experiences of four countries: Finland, France, Germany and Italy. After defining the scope of the report, the analysis starts with the attempt to measure the skills gap in the EU. It then delves into the main areas of attention, which represent also opportunities for public and private actors to contribute to address the digital skills gap in the EU:



Improve and increase ICT education and learning opportunities: more ICT graduates and professionals are entering the labour market at an increasing rate. Yet, enterprises report difficulties in hiring, largely due to a lack of trained professionals with education and training that meet companies' expectations. The research conducted indicates that there is a lack of dedicated courses, and that rigidity in university curricula is still considered a primary factor, despite increasing efforts to explore innovative training measures. While multiple initiatives and strategies at the EU level exist, they have limited effects in directly addressing these causes as the core competences in education still lie with the Member States. Industry can play a role

by offering greater access to learning material and certified courses, and by training educators in digital skills.

Prioritise talent within companies: up/re-skilling: the number of companies providing up/re-skilling opportunities varies by Member States, particularly in SMEs. Despite the importance that on-the-job training has, the research shows how many companies still lack a clear vision of future developments and, thus, skills needs and talent strategy. The policy response is, again, robust, but industry must develop R&D and market intelligence regarding talent strategy to better meet their up/re-skilling needs.



Women are grossly underrepresented in ICT and, therefore, are a large source of untapped talent. The gender imbalance in digital skills is accentuated at higher levels educational attainment, indicating that girls may need further encouragement to develop their digital skills in education. Surveyed female students report a desire to see more women in ICT leadership positions, to build strong careers, to pursue entrepreneurial ideas, as well as to contribute positively to a fast-changing world and society. EU policy has attempted to address these areas, but industry must do its part as well, for example, by raising interest in ICT careers for girls and providing for interdisciplinary career paths.

Drive collaborative digital skills ecosystems: despite efforts at the EU level, all actors (e.g. education and training providers, industry, national and local government, etc.) hold the belief that complete and effective cooperation is missing. Policymakers, industry, education and civil society will need to not only build the right opportunities to cooperate but also to identify and use a common language to make cooperation effective.



Invest in the digitalisation of public services: our research has shown that digitalisation of public services and procedures is strongly associated with preparedness to adopt and integrate digital learning into the educational ecosystem, underlining its critical role in the digital-green transition.

The final section of the report presents the main conclusions stemming from the analysis, providing suggestions on possible room for action from the main actors.



Introduction

The dual digital-green transitions, amplified by the COVID-19 pandemic, are rapidly changing labour market demands in Europe and rendering digital skills increasingly important. These disruptions have been transforming skills demand with various consequences, in terms of mismatch and frictional unemployment. Skill mismatches, gaps and shortages are impediments to economic growth and entrepreneurial success. The European Investment Bank (EIB) Investment Survey prioritises the lack of available skills as the most significant of nine obstacles to investment¹. Still, attempts to define, measure, and qualify these concepts remain elusive.

Huawei and All Digital, supported by EY Italy, have collaborated to better understand the digital skills gap, its main drivers, and the opportunities it presents. We present possible solutions and actions that key actors, starting from industry, can design and implement to address the gap and promote digital skills. The study aims to assess the digital impact in different environments and across different cultures.

This report focuses on the European Union (EU), covering 27 Member State legal systems, political infrastructure, and stages of technological advancement, all united under the EU flag and *acquis communautaire*.

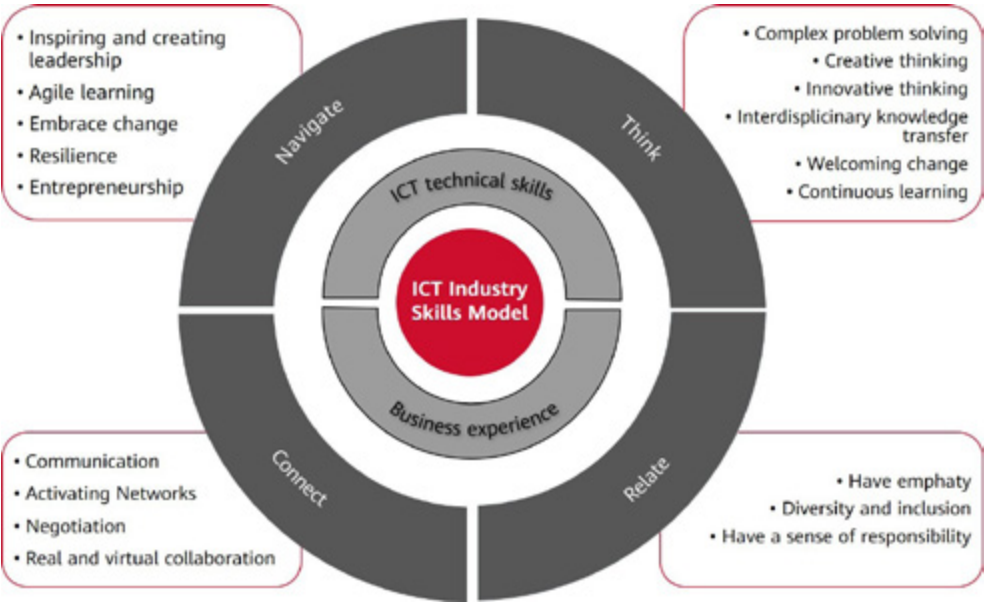
In this context, this report aims to accomplish the following three main objectives.

- First, it will attempt to highlight key elements that characterise the current digital skills gap in the EU, including the main challenges the companies report related to the phenomenon.
- Secondly, it aims at analysing the phenomenon to define, compare, and map policy and industry responses.
- Finally, the report shall identify where and how industry - together with the other public and private actors - can play a role in shaping the ecosystem in the next decade.

We have reviewed and elaborated on existing information and data, combined with original insight coming from interviews² and surveys³. Four case studies have been conducted - in Finland, France, Germany and Italy - to investigate different approaches at the country level, given different EU MS contexts.

We will cover the objectives of the study by defining the skills gap and digital skills as well as the scope of the study before attempting to measure the digital skills gap in the EU. From there, we continue describing the areas of attention we

Figure 1 – The ICT industry skills model.



Source: Authors’ elaboration.

identified. Within each area, we consider each of the four Member State case studies to examine how these areas play out on the national level and to what extent the indicators might relate to different national approaches. Finally, we will wrap up each section with examples of industry responses to the challenges identified in the main areas of attention before drawing our final conclusions.

For comparability across regions, we adopt the OECD definition of skills relevant to the labour market, including both cognitive and non-cognitive abilities as well as abilities specific to a particular job, occupation, or sector (technical skills). In this framework, skill gaps are understood as the combination of skill mismatches and skill shortages. Skills mismatch is the difference between the supply and demand for skills and

can be identified in an over or un(der)-qualified workforce. Skill shortages, on the other hand, refer to the lack of qualified professionals to fill certain positions. They can, thus, be measured in terms of unfilled vacancies⁴. Furthermore, skills shortages can lead to skill mismatches when an employer hires an un(der)-qualified applicant for a position due to a lack of adequately skilled alternatives⁵.

The DigComp 2.1 framework serves as an EU-recognised framework for the definition of digital skills. However, we see the importance of including a broader set of skills, combining both hard and technical skills with horizontal, future- and change-oriented skills, integrating creativity, critical thinking and continuous learning, connection and collaboration with others. These skills, as our analysis will show, are already recognised as an

important element of any skill set, and will likely become increasingly important to opportunities for transformation as it continues to evolve.

Based on the core competences already included in the DigComp framework and on the WavEY competence model developed by EY Italy together with the Università di Roma “La Sapienza”, we have developed a model for ICT Industry skills (see Figure 1).

In terms of data, the Eurostat data sources featured in this report often refer to proficiency levels ranging from “low” to “basic” and “above basic”, drawing from previous versions of the DigComp framework. For more information on each of the proficiency areas, see the Annexes.

The geographical scope of this paper encompasses the EU-27 as a whole and the UK. As such, data and research are presented on the EU 27 Member States (EU-27) as well as the previous EU 28 Member States (EU-28) where differences prove insightful. The four case studies provide a more granular analysis of the state-of-play co-occurring on the national levels: Germany, France, Italy, and Finland. The chosen group includes MS from western, northern, and southern Europe; large and small populations; diverse economies and each country captures different stages of the digital transition. The selected MS also vary in the indicators chosen to represent the areas of opportunity or attention (see Table 1).

Table 1 - Comparison of the four case studies countries in selected indicators

Indicator	Finland	Germany	France	Italy
DESI 2021 Rank	2 nd	11 th	16 th	20 th
Percentage of ICT Graduates of total number of graduates	7.6%	4.5%	3.6%	1.3%
Companies providing ICT training to employees	38%	24%	15%	15%
Width of the gender gap in digital skills (percentage points) ⁶	-3	+6	+2	+7
Digitalisation of Public Services, DESI 2021	3 rd	16 th	13 th	18 th

Source: DESI 2021 and Eurostat ISOC_SKE_ITTN2 data.

Notes

1. Source: European Investment Bank.
2. Thirty-two interviews were conducted with key stakeholders, including policymakers, industry representatives, members of the academia and students.
3. Two surveys were launched, one targeting EU companies (and receiving 55 responses), and one targeting alumni and students of Huawei's key initiatives, including Huawei ICT Academy, Seeds for the Future programme and European Leadership Programme (receiving 44 responses).
4. With some caveats considering the competitiveness of those vacancies (i.e., a position may remain vacant because it is not competitive in terms of wages or working conditions rather than the lack of qualified applicants).
5. McGuinness, S., Pouliakas, K. and Redmond, P. (2017), How Useful Is the Concept of Skills Mismatch? IZA DP No. 10786.
6. This value is the difference in percentage points between the percentage of male population with at least basic digital skills and the female population with the same feature, according to Eurostat isoc_sk_dskl_i data. A negative result indicates a more skilled female population.



01. Measuring the Skills Gap in the EU



Beyond the wide range of digital skills and ICT specialists across the Member States, the digital skills gap in Europe is difficult to quantify as it is demonstrated not only by the shortage of ICT specialists but also by the number of unemployed and under-skilled ICT specialists.

In 2014, Former Commissioner Androulla Vassiliou wrote in her letter to EU education ministers: “if we do not appropriately address [ICT skills shortage] issue at the EU and national level, we may face a skills shortage of up to 900,000 ICT professionals by 2020”⁷. Verifying Commissioner Vassiliou’s statement presents several difficulties in quantifying the digital skills gap. Nevertheless, we estimate that the deficit in the number of ICT professionals in 2020 was quite a bit less (353,592) than that predicted in 2014. The digital skills mismatch, however, is estimated to be much larger (1.4 million), indicating that much of the shortage in ICT professionals has been

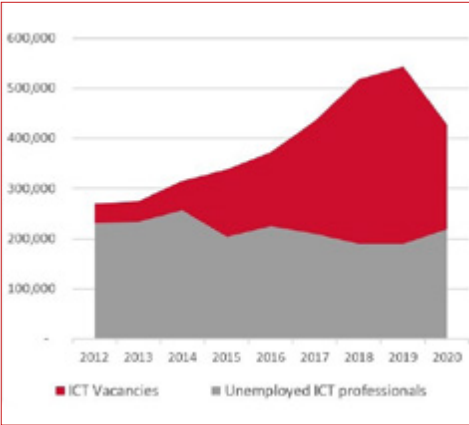
addressed through the hiring of underqualified ICT specialists.

In 2020, there were 8.4 million ICT specialists in the EU-27⁸. We propose using job vacancies for employment in the information and communications sector as an indicator to determine the skills shortage, or how many more ICT specialists the market demands⁹. In 2019, there were 543,392 vacancies in this sector across the EU-27¹⁰.

At the same time, there were 189,800 unemployed ICT professionals. The difference between these two indicators, or a deficit of 353,592 specialists, can act as an estimate of the digital skills shortage¹¹. As depicted in Figure 2, vacancies in the information and communications sector have increased rapidly since 2012 to outpace the available ICT talent pool.

For measuring digital skills mismatch, rather, we used the EU data on digital skills proficiency

Figure 2 – Job vacancies and unemployment ICT specialists



Source: Authors’elaboration of Eurostat JVS_Q_ ISCO and ISOC_SKI data.

levels for ICT professionals¹². Remarkably, 18% of ICT professionals had low overall digital skills in 2019 across the EU-27¹³. Given the number of employed ICT workers, this translates to an estimated 1.4 million under qualified ICT professionals. Combined with the digital skills shortage, as estimated above, we find that the EU-27 struggled with a digital skills gap in the ICT sector of approximately 1.8 million ICT experts in 2019, both in terms of missing talent and in terms of under- qualification of employed ICT specialists, with, however, the digital skills mismatch accounting for a large part of that gap. As such, it appears that the EU needs more ICT professionals, but, even more so, it needs digital upskilling of its employed ICT professional other and other personnel across much of the occupational spectrum.

Indeed, if we compare the EU to economies of similar economic/demographic size and level of development, we see that the EU does not lag much behind in terms of ICT specialists. The EU falls second to only Japan in terms of the percent of ICT specialists in the workforce. On the other hand, the EU produces relatively fewer ICT graduates (on the overall number of graduates) than both China and the USA, suggesting difficulties in keeping a steadily growing number of ICT specialists in the workforce. Moreover, the EU general popula-

Combined with the digital skills shortage, EU-27 digital skills gap in the ICT sector included around 1.8 million ICT specialists in 2019.

Table 2 – Key indicators on digital skills in the EU vis-à-vis third countries

Indicators	EU-27	USA	Canada	China	Japan
Population with at least basic digital skills	57%	61.5%	66.5%	61% ¹⁴	54.3%
Workforce lacking basic digital skills	37%	30.1%	32%	28.3% ¹⁵	49.2%
ICT specialists in workforce (2016)	3.7%	3.12%	3%	2.2% ¹⁶	3.8%
Percentage of ICT graduates (2018)	4.3%	8.3%	2.9%	4.7%	1.4%
Fixed broadband subscriptions (per 100 people, 2020)	36.6%	36.4%	41.8%	33.6%	93%
Percentage of women in ICT*	18.5%	31%	28%	31%	34.4%

Source: Authors’ elaboration of data from OECD Skills Matter: Additional results from the Survey of Adult Skills Annex A Table A2.7, OECD Digital Economy Outlook 2017, Eurostat data ISOC_SK_DSKL_I, ICTC Canada Q4:2021 Report, The World Bank data IT.NET.BBND.B2 - * Some figures may be slightly over- or underestimated due to occupational classification differences, though across the board the figures consistently illustrate the drastic lack of female representation in ICT occupations.

tion outperforms only Japan's in terms of the percent of the population with at least basic digital skills. We have summarised some of the key statistics for benchmarking the EU with comparable countries in terms of digital skills (see Table 2).

To analyse the magnitude of the digital skills gaps across the EU Member States, we have divided the former calculation (digital skills shortage + digital skills mismatch) by the entire labour force of each Member State to make the figures relative to the Member State population size. We have then taken the average of this figure between 2015 and 2019. Doing so has led us to find that the digital skills gap roughly tends to be greatest in Member States ranking among the highest in the Digital Economy and Society Index (DESI), with the notable exception of Romania (and, to a smaller extent, Hungary, and Czechia).

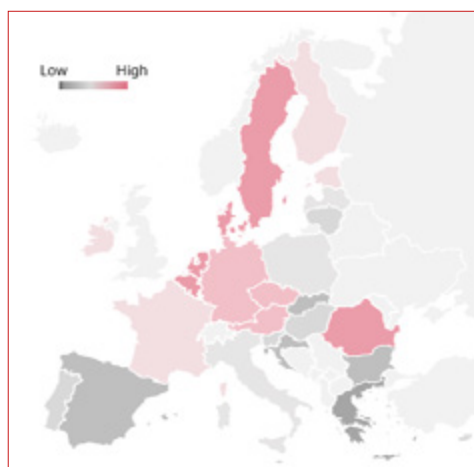
Analysing the factors used to estimate the digital skills gap provides two explanations for this phenomenon. First, the percentage of ICT professionals

with low digital skills in Romania is the highest in the EU. Nevertheless, there is a large ICT workforce, resulting in high digital skills mismatch. Secondly, the number of ICT vacancies is relatively high in Member States with high DESI rankings, indicating a greater digital talent shortage. It is important to note that the digital skills gap is even negative in certain years and in certain Member States, typically those on the lower part of the DESI spectrum. This occurred when unemployed ICT professionals outnumbered ICT vacancies to a high enough degree to overcome digital skills mismatch as well, creating a surplus in ICT professionals.

In addition to ICT specialists, a joint letter by ALL DIGITAL and member associations in 2022 called on national Ministers to "ask the Commission to develop a new Digital Decade target on cybersecurity. For example, the EU should propose a package to help to immediately train 200,000

cybersecurity experts (the number of experts Europe lacks today) and develop a long-term plan to train 1,500,000 cybersecurity specialists by 2030 to fill future demand"¹⁷. The 2021 figure is an increase from the estimated 168,000 shortage in 2020¹⁸. Similar to leading the EU-27 with the most cybersecurity professionals, Germany also led with the largest gap in 2021 at

Figure 3 - Member States' Digital Skills Gap Estimations



Source: Authors' elaboration on Eurostat.

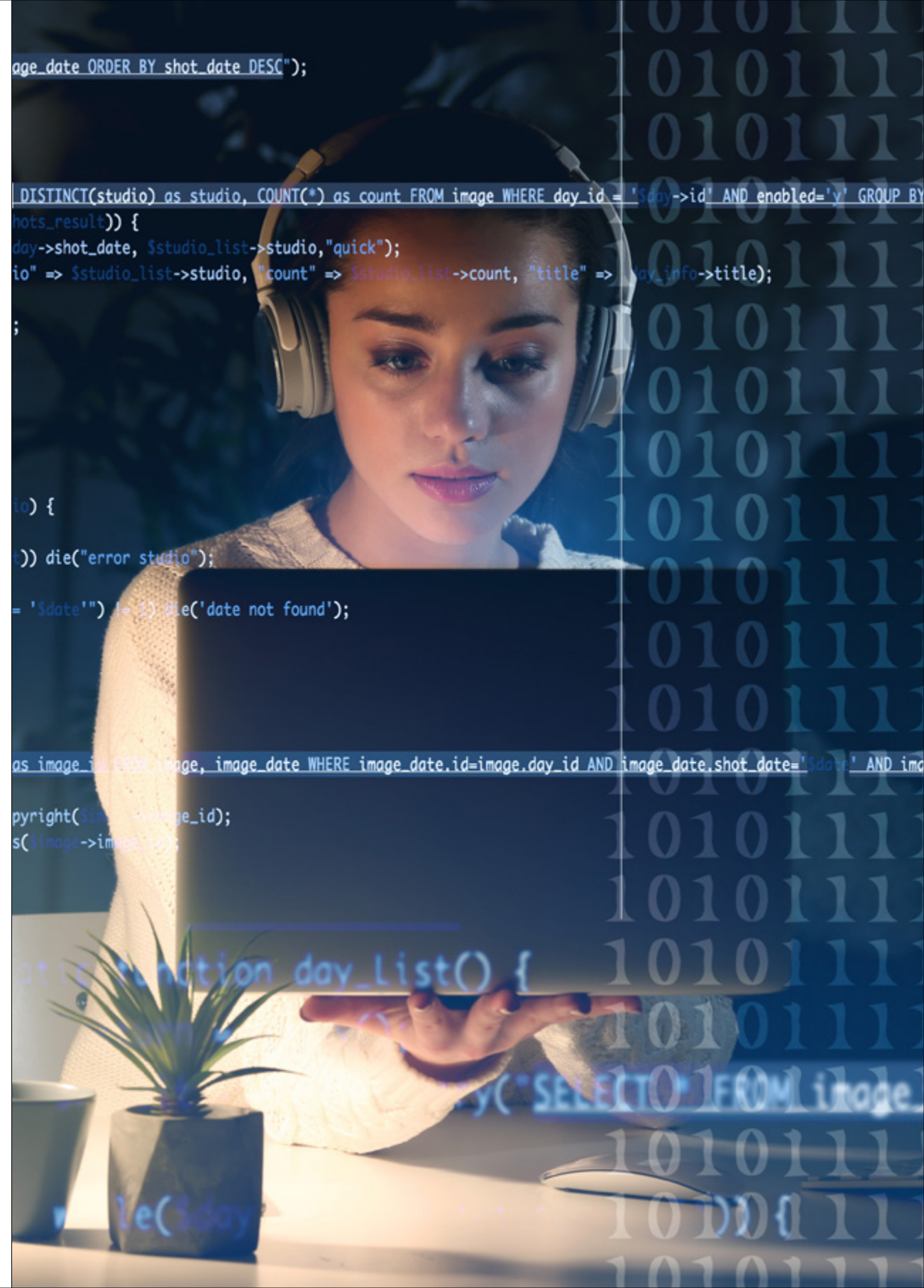


an estimated 68,000 personnel. To fill the estimated gap of 2021, Germany would have needed to increase its 2021 cybersecurity workforce by just over 14%. Spain follows with a gap of 38,000 and France with that of 28,000. To meet their 2021 needs, Spain would have needed to increase its 2021 cybersecurity workforce by 30% and France by 19%¹⁹. In 2021, the cybersecurity workforce in the EU was made up of over 1,086,000 professionals, a jump up from 840,000 in 2020²⁰. Germany led the EU-27 with over 464,000 professionals in the cybersecurity workforce, increasing from 175,000 in 2020. COVID-19 pandemic related economic migration and Brexit likely contributed to this jump, as during the same period the UK's force dropped by nearly 70,000 (from 366,000 in 2020 to 300,000 in 2021). As of 2021, Germany was followed by France (146,800) and Spain (124,000) with the largest cybersecurity workforces.

The EU needs more ICT professionals, but, even more so, it needs digital upskilling of its employed ICT professionals and other personnel across much of the occupational spectrum.

Notes

7. Source: European Commission press release of 29 July 2014: “Vassiliou urges Education Ministers to help kids crack the code”.
8. Eurostat ISOC_SKS_ITSPT.
9. The information and communications sector is a close but imperfect proxy for ICT, which is not a NACE Rev. 2 economic activity, in the absence of more specific NACE Rev. 2 level 2 data on job vacancies at the EU level. It includes telecommunication activities, computer programming, and information service activities (e.g., data processing, hosting and related activities) but also publishing and broadcasting activities, which we accept considering the relative size of the more relevant economic activities within the information and communications classification. It is also possible it underestimates due to ICT positions outside of this sector.
10. Eurostat JVS_Q_NACE2.
11. We consider unemployed ICT professionals as a valid indicator because, in theory, the hiring of an already employed ICT specialist for a vacancy would create another ICT vacancy and because hiring a non-ICT specialist introduces digital skills mismatch, which we attempt to capture with our skills mismatch indicators.
12. We considered only this occupational area because it provided us with the clearest indications of relevant digital skills mismatch. Nevertheless, 15% of manual workers had above basic digital skills during the same period. To calculate the number of manual workers, we considered: skilled agricultural, forestry and fishery workers (ISCO – 06) e.g., field crop and vegetable growers; craft related trade workers (ISCO – 07) e.g., bricklayers and related workers; plant and machine operators and assemblers (ISCO – 08) e.g., miners and quarries, and elementary occupations (ISCO – 09) e.g., domestic cleaners and helpers. As such, we estimate the number of overqualified manual workers at 9.6 million.
13. Eurostat ISOC_SK_DSKL_I.
14. The World Economic Forum.(2019) The Global Competitiveness Report 2019, Insight Report..
15. Source: World Economic Forum.
16. “Skills shortages and labour migration in the field of information and communication technology in Canada, China, Germany and Singapore”, wcms_755663.pdf (ilo.org), p. 22. This value does not include the ICT manufacturing and ICT trade sectors.
17. DIGITALEurope. Joint Letter with Memer Associations. Retrieved March 18, 2022.
18. (ISC)2. Cybersecurity Workforce Study. 2021. Retrieved March 18, 2022.
19. (ISC)2. Cybersecurity Workforce Study. 2021. Page 26. Retrieved March 18, 2022.
20. (ISC)2. Cybersecurity Workforce Study. 2021. Page 5. Retrieved March 18, 2022.



Areas of attention and opportunity to address the skills gap



The ubiquity of problems created by the digital skills gap in Europe calls for an integrative, strategic response involving all shareholders in order to match evolving labour market demands, reverse growing inequalities, and promote an inclusive and sustainable society.

The objective of the analysis presented in this chapter is to identify the main factors that contribute to the digital skills gap and what may constitute areas of attention and opportunity for action. Our analysis allowed us to identify the following factors, described further below:

- Increasing and improving educational opportunities
- The importance of up/re-skilling and awareness of skills needs
- Supporting and encouraging women's participation in ICT
- Fostering collaboration within the digital skills ecosystem
- Digitalisation of public services and digital infrastructure

An elaborated analysis of each of these findings is presented below. It builds on the review of relevant literature, triangulated with input collected through interviews and surveys.



Improving and increasing educational opportunities

Key insights

- Students are not fully prepared with relevant skills and cannot fully apply what learnt in school
- Rigidity of university curricula limits incorporating new skills as they become relevant
- Schools and universities lack adequate infrastructure and appropriately skilled teachers to properly prepare students

About 2.9 million people in the EU-27 labour force had an ICT education in 2020 while the employment rate of those with an ICT education is up to 92.5%²¹. About 64% of all ICT specialists have a tertiary education (ISCED levels 5-8). More ICT professionals have a tertiary education than other technicians and associate professionals as well, about 43% of which have a tertiary education²², indicating that the ICT profession is relatively abundant with highly educated individuals.

Despite the growing pool of highly educated ICT specialists, 55% of all EU-27 enterprises that tried to recruit personnel for jobs requiring ICT specialist skills in 2020 had difficulties in filling vacancies. Among the most commonly reported reasons for recruiting difficulties was a lack of ICT qualifications from education/training, reported by 38% of enterprises. It stands to reason, therefore, that either the relatively highly educated ICT professionals are lacking the skills that employers are seeking despite high-levels education or, conversely, employers are too demanding in terms of the qualifications they expect from education/training.

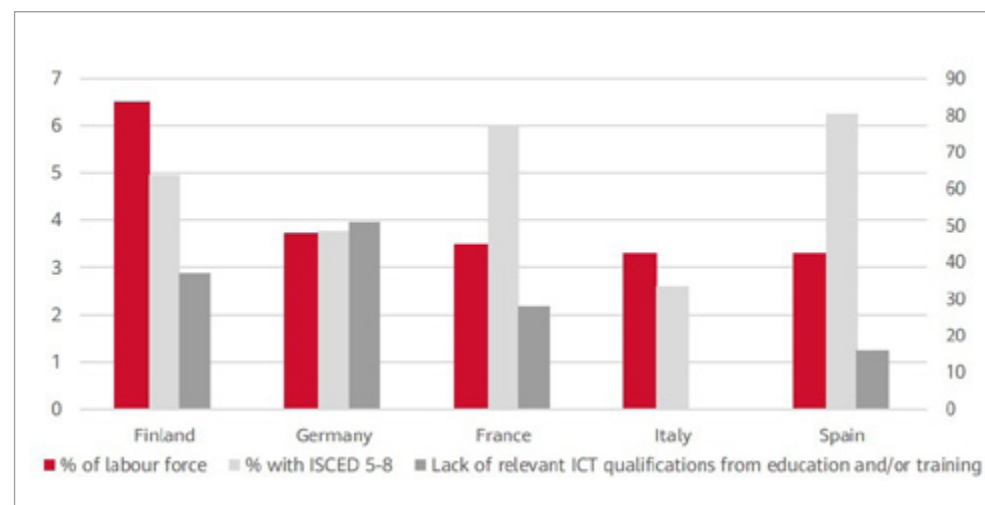
This issue manifests differently across Member States. For instance, the portion of ICT specialists in the overall labour force varies drastically with 6.5% of Finland's labour force employed as ICT specialists compared to only 1.9% of Romania's. Furthermore, over 80% of Spain's employed ICT professionals received a tertiary education compared to about 34% in Italy. Meanwhile, the percent of enterprises reporting difficulty in recruiting ICT specialists due to a lack of qualifications from education/training, among those that attempted to recruit, ranged from 60% in Austria to 16% in Spain.

Figure 4 compares these indicators across a few select Member States to demonstrate that enterprises that experience greater difficulty in their attempts to recruit ICT specialists due to a lack of qualifications from educa-

The majority of EU enterprises that tried to recruit personnel for ICT jobs in 2020 reported difficulties.

tion/training were often located in Member States where the share of employed ICT specialists with tertiary education is lower and, variably, where ICT specialists make up a larger share of the total labour force. We can infer from this finding that the digital skills gap is influenced by educational systems and requirements as well as the degree of digitalisation of the labour market (see *Figure 4*).

Figure 4 - Digital education indicator comparison in select MS²³



Source: Authors' elaboration of Eurostat datasets: ISOC_SKS_ITSPE, ISOC_SKS_ITSPT, ISOC_SKE_ITRCRN2.

Comparatively, the majority of companies answering the survey conducted for this report indicated that ICT students are, in their view, not sufficiently prepared and trained in digital skills (and in the right set of digital skills), at least to some extent (see *Figure 5*).

Another challenge identified in the survey for industry leaders concerns the extent and pace at which university curricula align with industry needs in terms of topics and skills (see *Figure 6*). While most companies report that the current misalignment of curricula is a problem to some extent, all respondents agreed that university curricula change too slowly in response to industry demands.

Finally, industry representatives also reported that they believe universities are constricted by structural issues. In particular, the limited number of adequately skilled instructors, lack of infrastructure (such as laboratories and equipment), and a more general lack of resources may be factors that hamper the capacity of the education system to react to rapid changes and rela-

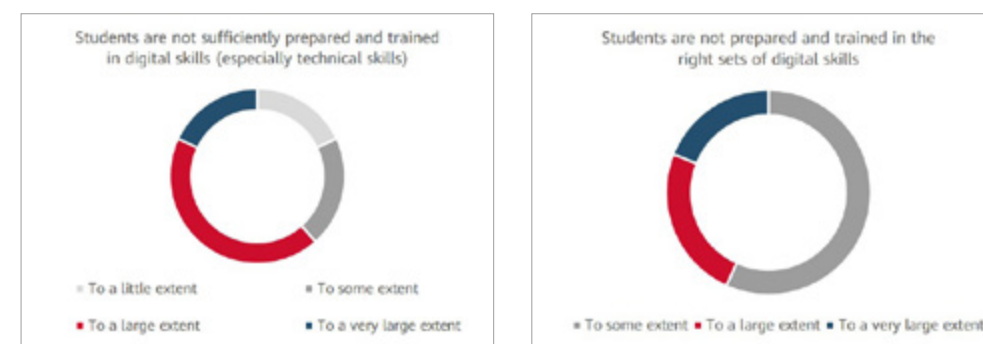
The digital skills gap is influenced by both the readiness of the educational system and the degree of digitalization of the labour market.

ted skills needs (see *Figure 7*).

Interviews also indicated how rigid institutional requirements often prevent faster procedures, limiting the ability of education schemes across the region to adapt and prepare their students for modern, evolving industry demands. Examples of educational institutional rigidity from our research include institutional processes for employment as fully qualified teachers²⁴, potentially stifling the flow of younger, more digitally competent instructors. Indeed, the European Association for Quality Assurance in Higher Education (ENQA) recognised that a rigid approach to educational standards threatens the existing confidence that the European Higher Education Area (ESG) can be a unifier across a broad range of national and organisational contexts²⁵.

Rigid institutional requirements often limit the ability of education schemes to meet evolving industry demands.

Figure 5 - Industry reported challenges with how students are prepared and trained



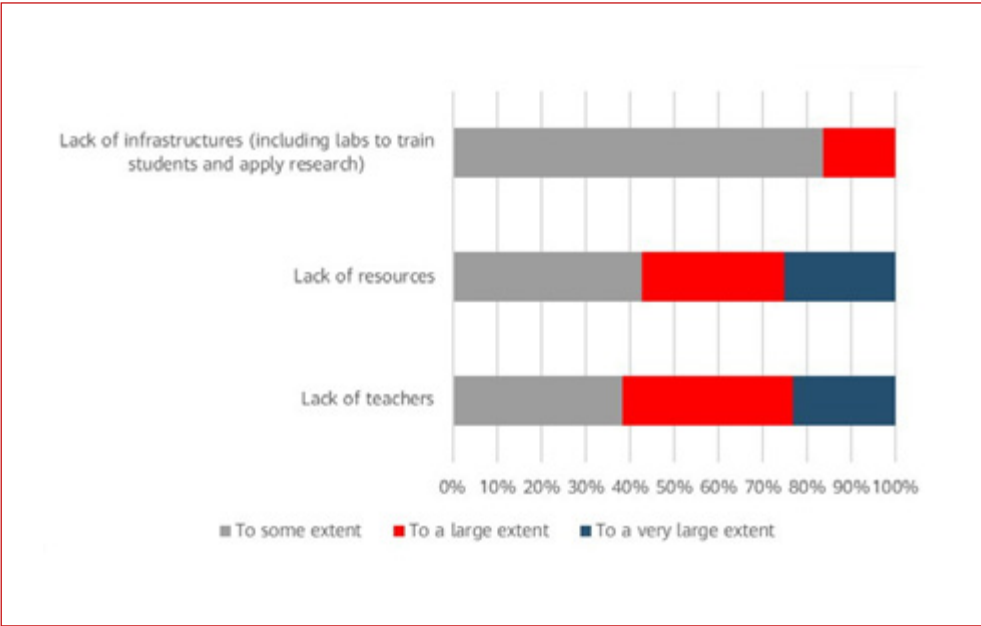
Source: Authors' survey to companies on digital skills and talent in the EU.

Figure 6 - University curricula do not keep up with the pace of industry needs



Source: Authors' survey to companies on digital skills and talent in the EU.

Figure 7 – Structural shortcomings in universities may hamper their capacity according to companies



Source: Authors’ survey to companies on digital skills and talent in the EU.

Another problem contributing to the digital skills training mismatch is the limited correspondence between skills taught to the students in universities or professional training courses and skills and competencies needed by industry. This could be one of the factors that limit the utility of many initiatives aimed at reducing the skills shortage. The analysis has shown how some of the leading technologies considered top priorities by industry (see Figure 15) are not always part of university curricula. For instance, courses regarding or integrating topics such as IoT, 5g and cloud computing (regarded as top priorities by industry), seem only partially present in university curricula²⁶ even though they represent key technologies for the future development and competitiveness of the industry.

Huawei ICT Academy provides training on a vast array of topics and technologies, based on the main needs of technological companies. Ranging from IoT to AI, from cloud computing to Big data and 5G, the learning offer represents an opportunity to complement university courses and laboratories.

Box 1 - Insight from case studies on educational opportunities and certifications



An analysis of the four case studies revealed a trend for higher levels of digital skills in a country corresponding to more advanced and specialised educational opportunities. The topics covered by courses tend to deal with specific topics such as AI, robotics, data science, etc. rather than generic digital skills. In Finland, a European digital frontrunner, students are exposed to more advanced topics, particularly AI. This method familiarises the general public with the fundamentals of the field, foreseeing a proliferation of this technology in the future. The educational opportunities provided are planned to ease the next step of Finland’s digital transformation²⁸. On the other hand, in countries like Italy, at the bottom of the DESI rankings, the main and most widespread educational opportunities provided in the national framework for

digital maturity deal with the basics of ICT²⁹. Regarding certification systems, CertiProf is a private company in France and the major provider of professional certifications, with the main digital skills certification being the ClèA Numerique. The French State fully recognises this certification, and it is included in the National Framework for Qualifications. In many cases, it is possible to enrol in the courses with public funding, so with no costs for the applicant, specifically in light of the official status of these courses. In the French ecosystem, according to our primary research, industries and private firms are very aware of the existence of this certification and, more importantly, of the quality of the training offer connected to it, mainly thanks to the French State guaranteeing its adequacy.

The balance between educational regulation, independence and autonomy within universities is a long-standing challenge²⁷, though, with the advancement of technology and dynamism of ICT, it is increasingly important that regulation refrain from limiting the ability of universities to keep curricula up to date with the advancement of the industry.

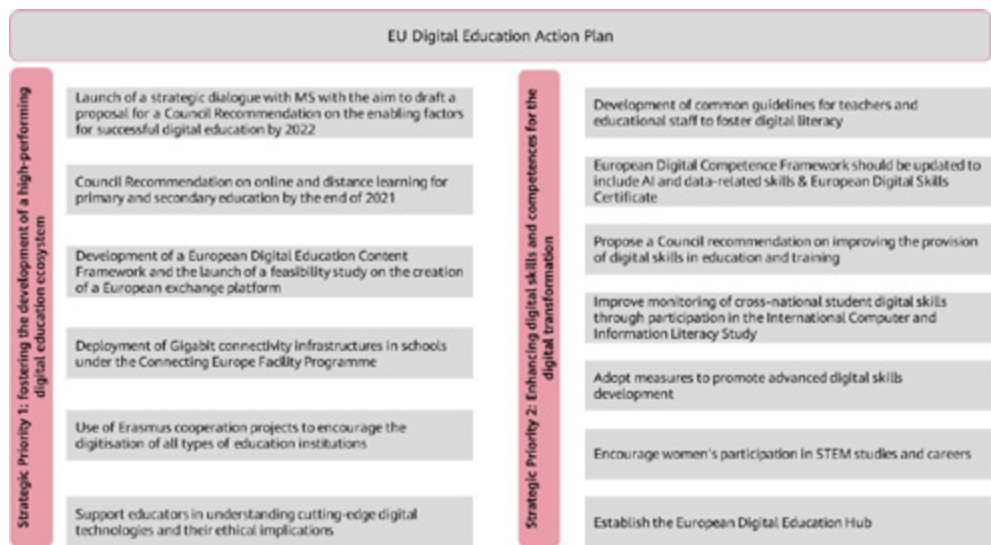
EU Policy Responses

Several EU policies and initiatives have been developed in the area, and, more in general, to promote digital skills, showing the intent of the European Commission to address the digital skills gap, promoting projects and strategies to improve the level of digital skills in Europe.

The Commission has set targets in the European Skills Agenda³⁰ and the Digital Education Action Plan³¹ to ensure that 70% of adults have basic digital skills by 2025 and 80% by 2030. The entire EU population between 2015 and 2019, had nearly as many people with low digital skills as with basic and above basic digital skills. To reach the Commission’s target of 70% of adults with at least basic digital skills by 2025, a large portion (about 60%) of those with low digital skills will need successful digital up-skilling.

Twelve actions are laid out in the European Skills Agenda, with Action 12

Figure 8 - EU Digital Education Action Plan Strategic Priorities and Actions



Source: Authors’ elaboration.

directing EU funding to support MS and private actors’ investment in digital skills among employees, while Action 6 includes the establishment of ICT-Jump-Start training and the Digital Crash courses for small and medium enterprises (SMEs) to provide short-term intensive training to address ICT skills shortages. Partnerships with digital skills training providers will be made for these courses.

The Digital Education Action Plan offers a long-term strategic vision for high-quality, inclusive, and accessible European digital education, particularly in the light of the COVID-19 pandemic³², and the digital transformation (see Box 3 below on the pandemic’s impact on the demand for digital skills). It aims to support sustainable and effective education and training systems in the EU by promoting the adoption of digital technologies. The new plan aims to create equal access to digital tools and learning opportunities for all MS. This would improve the quality and fairness of education in the EU and support the “green transition” towards a carbon-neutral economy, relying heavily on modern digital technologies.

The Action Plan also addresses the difficulty faced by businesses in hiring workers with an adequate level of digital skills as a consequence of insufficient training. These workers may struggle to find employment or to remain competitive in the labour market while businesses, especially SMEs, face the risk of losing competitiveness due to the lack of a digitally skilled labour force. The Action Plan is divided into two strategic priorities and each priority has its respective actions as summarised in *Figure 8*.

In addition, several funds and instruments have been put in place at the EU level, providing funding for investments to address the digital skills gap. In particular:

- The Recovery and Resilience Facility: 20% of its funds must be spent on the digital transition of Member States, including on digital skills
- The Digital Europe Programme: with a budget of around €200 million for 2021 and 2022, it has the promotion of digital skills as a core element
- The European Social Fund Plus: to support EU Member States in reforming national education and training systems, supporting key skills, including digital ones
- The European Global Adjustment Fund: supports trainings in digital skills to help laid-off workers find another job or set up their own business.
- Horizon Europe: finances grants for master, PhD and post-graduate research activities in all fields including digital through Marie Skłodowska-Curie actions as well as the European Institute of Innovation & Technology (EIT).

Companies can intervene to increase availability of training resources.

Box 2 – COVID-19 in the EU and digital skills

In 2020, 76.2% of companies globally said ICT skills would be necessary to cope with new challenges presented by COVID-19, 49% among European respondents. ICT skills for digitalisation of workplaces and digital design, research, and problem-solving accounted for 64% of the skills sought by EU employers. Rise in e-commerce, consumer trends opting for cheaper, less-labour intensive goods, and increasing cultural acceptance of – if not preference for – automated interaction following the pandemic have driven demand for digital skills while cutting demand for previously in-person, manual jobs³³.

Demand for digital skills within non-ICT sectors has increased during COVID-19, particularly in the retail and service sectors. Lockdowns and restrictions that limited physical movement and

store openings led to a surge in e-commerce and online retail. In the EU, most e-commerce takes place in Western MS (64%), with an unchanged growth rate (4%). However, e-commerce in Eastern Europe experienced a growth rate of 36% in 2020. Central and Southern Europe maintained stable, strong growth rates (28% and 24%, respectively).

In the manufacturing and automotive industries, the adoption of more resilient productions systems may result in reshoring facilities from remote or overseas locations. As these industries undergo digitalisation and embrace industry 4.0 practices, reshoring facilities back to the EU would increase the demand for digital skills and ICT specialists.



Opportunities for Industry Action

Industries can help increase the possibilities for students and workers to access new learning material and opportunities. This can help industry attract and train more people in the areas and topics that are relevant to their business and to fill the gap that university curricula may leave in terms of both competencies and practical application of the knowledge.

According to our analysis, one of the most beneficial approaches that private companies have to contribute to rampant skill mismatch is to make training resources available to a larger share of the active population, beyond their personnel. This might be more problematic when the course level is advanced since most people are not equipped with the knowledge to learn from a course designed for ICT specialists. ICT training designed to teach a basic level of digital skills can benefit motivated individuals who want to improve their skill set.

A clear talent strategy is often a missing component of companies' digital transformation

Microsoft Skills Academy is a training and certification programme designed by Microsoft and available for purchase to the general public on how to operate Microsoft apps and the Office suite. Offering specific skills courses for 13 different job paths, ranging from AI engineers to administrators, the courses provide content for levels ranging from junior to advanced IT professionals. Students can earn certification via the Microsoft Professional Exams. This is a for-profit venture where the end-user pays for the courses.

Grow with Google is a project focused on, but not limited to, European countries. It provides courses, of variable duration and importance that cover a wide range of topics, many of which deal with digital skills. The courses are free, easily accessible online and some of them give access to an official Google certification.

Huawei ICT Academy has a broad and comprehensive scope and focus. The Academy was launched in 2013 and has now a global presence, covering 72 countries. The courses are available for free for universities and training institutions, both in the form of training material for teachers and in the form of learning modules that can be added to the existing curricula. These entities also receive free support from Huawei. Teachers and students, alike, have free access to training, educational contents and simulation tools. If they want their competence to be certified, they can apply for a free voucher for any exam. If they want to explore these subjects more, they have access to Huawei's Industry Masterclasses, virtual Industry Tours and

annual ICT competitions.

Seeds for Future is Huawei's flagship global corporate responsibility programme. Launched in 2008, the programme aims to develop skilled, local ICT talent and bridge communication between countries and cultures. The programme targets young people from different countries who can learn about advanced technologies in the ICT industry and accumulate expertise. The programme promotes greater understanding and interest in the telecommunications sector and seeks to improve and encourage regional building and participation in the digital community.

The Italian Fondazione Mondo Digitale (Digital World Foundation) launched a programme called Phyrtual Innovation Gym, a network of digital hubs that provide workshops, webinars and courses regarding high-tech topics, such as robotics, digital manufacturing and coding. The activities offered are available for everyone, from private citizens to schools to professional workers.



Linked to the previous point, industry can play a role in the provision of new opportunities for training and learning certifications. If company-issued certifications attesting successful completion of a certain course or learning path were officially recognised by governments or by other entities, whose role it is to guarantee high quality of training, other private actors currently experiencing the ICT talent gaps would be able to place more trust in applicants who earned those certificates. Government recognition of certificates can accelerate the shrinking of the digital skill gap, facilitating the connection between private companies and adequately skilled individuals.

At the end of Google Growth learning paths, official professional certification is issued, which not only is highly valued by other companies (82% of certificate graduates report a positive career impact in six months), but also benefits from a certain level of official recognition on an EU-level scale. The Growth with Google project received the European Commission's Digital Skills Award in 2016 and is included in the official EC's Pact for Skills.

Huawei issues professional certifications that are both held in high regard by other private actors in the ICT field and have been mapped to Pearson Qualification's BTEC Higher Nationals, internationally recognised higher education qualifications that are equivalent to university degrees. Huawei's training offering is structured around three tiers (Associate, Professional, Expert).

Finally, a critical target for improving the education systems will be equipping the educators themselves with the appropriate digital skills. As the backbone of any education system, teachers are the primary source of learning for students and should have certain competencies to support students in their learning process, but over 60% of surveyed companies believed that teachers and trainers with the right levels of skills are lacking. To this end, providing training and learning opportunities to teachers and trainers could be added value for the whole ecosystem.

Skills taught to students and those needed by companies are often not aligned.

Google Growth provides teachers with a dedicated section of their training offering, sorted according to the subject. These courses include a focus on digital skills: software lessons, focus on specific digital tasks, and training on optimal use of Google digital resources are some examples of content meant to improve the digital skills of teachers. On the other hand, there are also lessons and materials thought to facilitate the teaching of digital skills by the teacher to the students. However, Google's training offering is not limited to digital skills: the courses offer teachers with a wide range of resources to better their general performances in class, even when teaching subjects not directly connected with digital skills.

Huawei ICT Academy has different means to deliver digital training: one of these means is training teachers. They are offered free access to the training courses designed for their role, simulation tools, masterclasses, and other training opportunities. There are also Huawei-sponsored initiatives like the Instructor of the Year Award and the annual Instructor Forum.



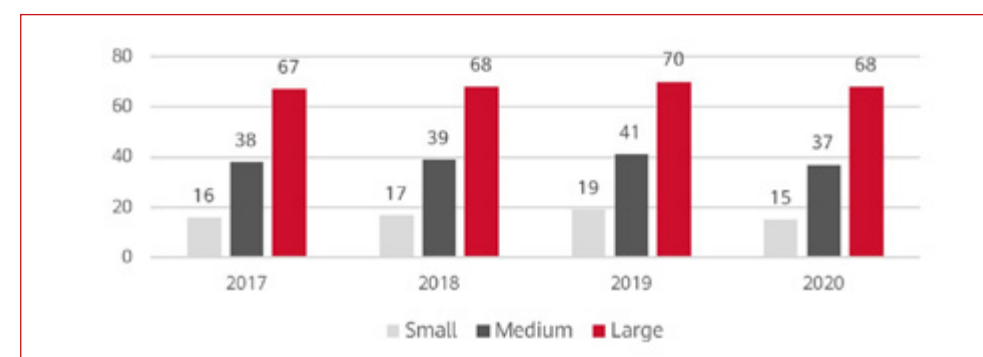
Prioritise talent within companies: up/re-skilling

Key insights

- Companies should prioritise talent in their digitalisation strategies
- Lack of clear understanding of skills needs limits ability to provide appropriate training
- Companies fear employee “flight risk” leaving after receiving up/re-skilling training
- Lack of resources and high upfront costs remain an obstacle for up/re-skilling actions
- Limited vision of future developments limits future planning of adequate skills training
- Companies need personnel with cybersecurity skills to mitigate growing vulnerabilities as a result of digitalisation

From 2012 to 2020, an average of 21% of all enterprises in the EU provided training to develop/upgrade the ICT skills of their personnel. The percentage of enterprises that provided such training increased slowly from 2012 until 2020, when it took a sharp dive, likely in relation to the COVID-19 pandemic (see Box 2).

Figure 9 - Percent of enterprises providing training in ICT skills by size (EU-27)



Source: Authors' elaboration of Eurostat data ISOC_SKE_ITTN2.

Differences emerge when looking at the size of companies. An average of only 15% of small enterprises in the EU-27 provided training in ICT skills for their employees, in stark contrast to a 68% average among large enterprises and 36% among medium-sized. Digital training for ICT specialists is

about half of that as for non-ICT personnel, with 10% of EU-27 enterprises providing training to further develop the ICT skills of their specialists. This figure has remained more stable than personnel training, only increasing by 2% since 2012.

We can infer that the barriers limiting the implementation of up/re-skilling activities reported in our survey results may be most relevant for SMEs, the backbone of the EU economy, rather than larger enterprises, which have greater access to resources and reduced cost through economies of scale.

The numbers also differ considerably across the EU, with some Member States hosting a greater share of enterprises that provide digital skills training than others. For example, Finland and Belgium hosted the greatest share of enterprises that provided digital skills training with each averaging over 30% of all enterprises between 2012 and 2020. On the other hand, in Romania and Lithuania, an average of less than 11% of all enterprises provided such training during the same period.

Whereas large enterprises provide relatively similar levels of training across Member States, there are greater discrepancies among small enterprises providing ICT training between Member States (on average between 2012 and 2020). Moreover, we can see that a greater share of Finnish enterprises provided ICT training for their personnel than in any other Member State across enterprise sizes.

Across the EU-27, in 2018, the most common methods for improving skills

related to the use of computers were free online training or self-study and on-the-job training, although only 10% of respondents reported having undergone such training. Only 2% carried out training paid out of pocket, 3% did training provided by public programmes or organisations, and 8% completed training paid or provided by the employer. As such, greater access to free online training and on-the-job training can reach a greater audience of potential learners to increase ICT skills.

According to our survey data, while companies recognise the importance of ICT talent and digital skills in remaining competitive, almost a third (28%) of companies reported not having a clear talent strategy to accompany and implement their digital transformation, suggesting that it is crucial that investments in digital talent become a priority for companies and all other actors. The EY CEO Imperative Survey³⁴ further corroborates these findings, with more respondents anticipating a significant investment in data and technology the next year than another other surveyed option (59% of respondents anticipated such an investment). Investing in people and talent, however, falls behind several other implementations – such as risk management, business models, innovation processes – the respondents expected to make in response to the presented trends. These results support the survey findings, indicating that while CEOs widely acknowledge technological impacts and are making investments to prepare for them, people and talent are not always at the forefront of these preparations.

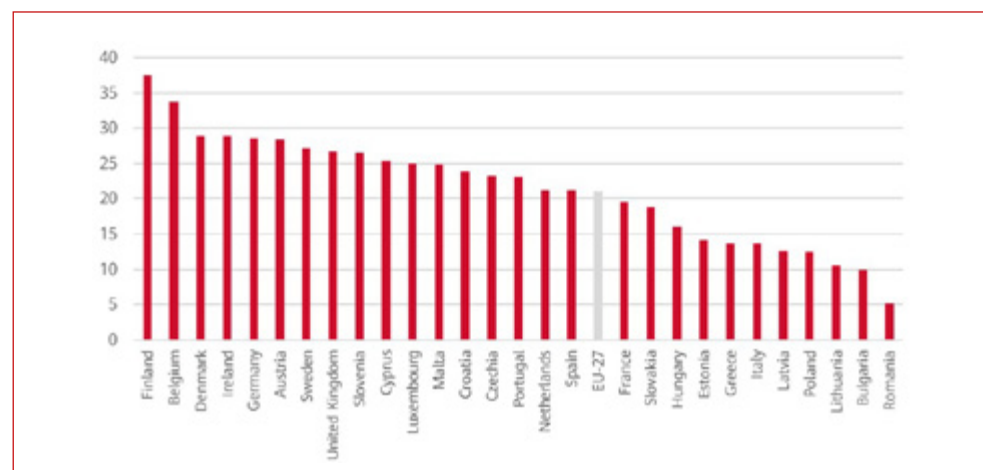
With on-the-job training among the most popular methods for digital upskilling, followed closely by training provided by the employer, the reported lack of a clear vision of future developments and, thus, skills needs, does not bode well for the efficacy of these methods. Therefore, greater access to employer-provided digital skills training, combined with a better employer understanding of future skill needs can act to bridge the digital skills gap.

A key element for awareness of digital skills needs relates to the extent to which companies have a clear vision and understanding of their future, of market and technological developments, and how these translate into skills needs. As shown in *Figure 11*, around 50% of survey companies admitted to having – at least to a small extent – limited knowledge and a clear vision about future developments, and therefore about the skills they will need to be competitive.

A possible driver of this lack of foresight is an investment in R&D. A clear idea of the skills needed in the near future emerges only when a company is not only following but also trying to anticipate the trends in ICT research and development, thus the future skill needs. It is not surprising

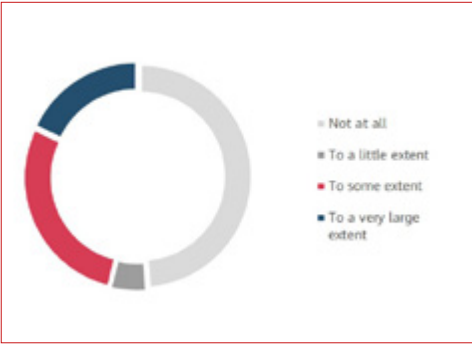
There are great discrepancies in the level of ICT training provided by SMEs across the EU.

Figure 10 - Share of enterprises that provide ICT training to personnel by Member State



Source: Authors' elaboration of Eurostat dataset isoc_ske_itn2.

Figure 11 – The extent to which companies have limited knowledge and lack of a clear vision of future developments

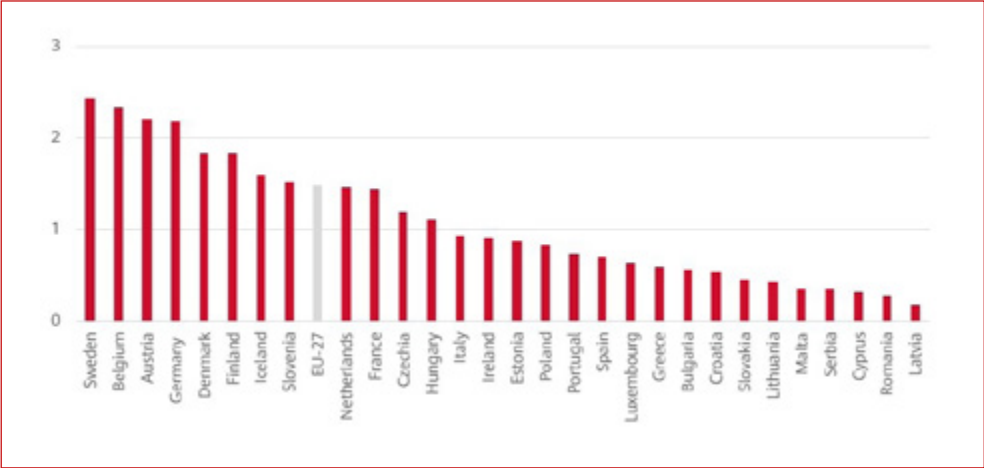


Source: Authors' survey to companies on digital skills and talent in the EU.

to find that the countries with the highest R&D investments in the business enterprise sector are also the countries where the digital skills gap is less severe. Many countries whose R&D investments are higher than average (as displayed in the Figure 12) obtained a positive result in the DESI rankings: Denmark, Finland and Sweden are ranked respectively first, second and third in the 2021 DESI. All countries that invest more than the average in R&D go on to achieve DESI scores higher than the EU-27 average. Our data analysis shows how significant R&D investments are, since the amount of money invested in the sector correlates positively with the DESI score in the "Human capital" indicator to a larger extent (0.63) than any other DESI indicator (Connectivity: 0.41; Integration of digital technology: 0.57;

Digitalisation of public services: 0.34). Interestingly, surveyed students also responded that companies, in their opinion, have difficulties understanding their needs³⁵, which has been reiterated in the inputs collected from interviewed experts. Awareness-raising surrounding skills needs is critical as it allows for the design and imple-

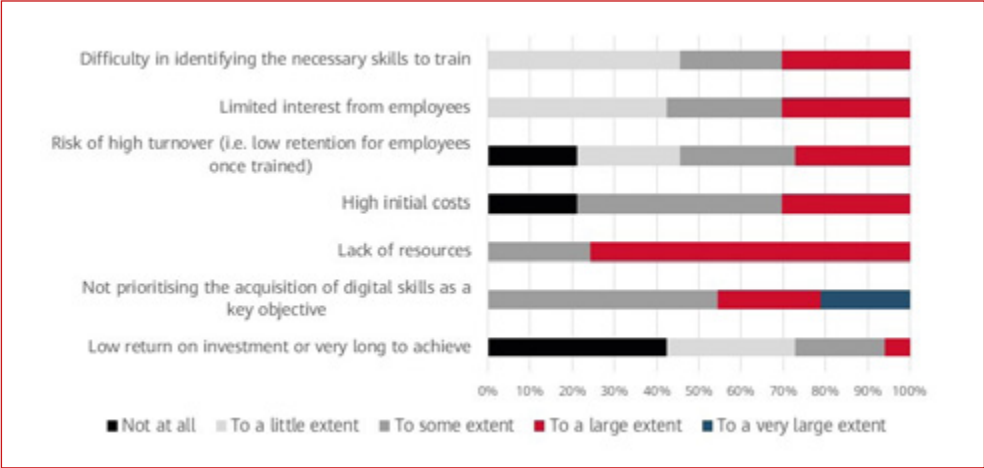
Figure 12 - Percentage of total GDP invested in R&D in the business enterprise sector (2019)



Authors' elaboration of Eurostat TSC_00001 data.

mentation of training activities that target companies' current and future needs. On the other hand, there are not only technical skills to consider but a wide range of non-technical, horizontal skills that are becoming increasingly important. Finally, when it comes to up/re-skilling activities, 64% of survey respondents indicated that they have experienced a limited capacity to handle the up/re-skilling of workers at some point, at least to a small extent. Among the challenges to implementing effective up/re-skilling activities, companies reported a lack of resources for this purpose, together with high initial costs and not prioritising the acquisition of digital skills as the factors with the greatest potential impact (see Figure 13). However, over half of respondents report the risk of seeing workers that have undergone up/re-skilling leave the company and the limited interest from employees to participate as hampering factors at least to some extent. The 2020 Future of Jobs report³⁶ found that over 17% of businesses were not even sure about the return on investment from re-skilling employees. The need for up/re-skilling is nonetheless present, as 77% of companies responded to the survey expressing the need for up/re-skilling more than 10% of their employees³⁷. According to the organisations surveyed, technical abilities will be the most important to maintain competitiveness in the next years. Survey respondents said they frequently do not have the skills needed to realize the technology's investment value among the technologies they use now or intend to

Figure 13 – Main factors reported by industry that may limit the implementation of up/re-skilling activities



Authors' survey to companies on digital skills and talent in the EU.

The number of women in ICT remains low due to multiple factors.

use in the future 3-5 years. Further, there is a substantial gap between the importance of specific skills and a company's current maturity across the full range of digital technologies.

Student survey respondents (see *Figure 14*) and industry experts interviewed agree that non-technical, horizontal skills are critical for businesses as they embark on their digital transformation. The increased availability of data requires critical analytical skills to turn data into useful insights. For instance, the EY study on the future of skills³⁸, while limited to the Italian labour market, has shown how non-technical skills such as decision-making, creative thinking and adaptability will be crucial for all workers in the next decade, and how these skills must be integrated into training, up/re-skilling initiatives. It becomes fundamental, then, for companies – but also policy-makers and the education system – to design and implement innovative

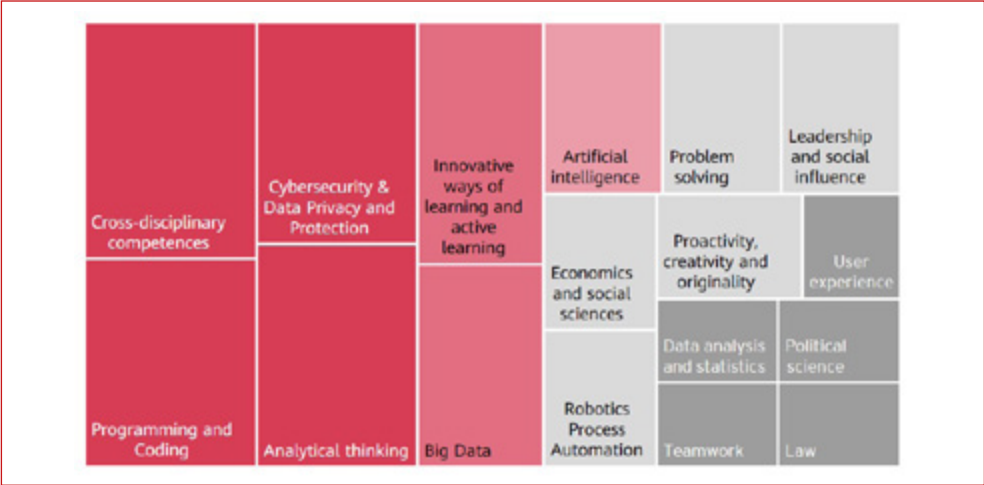
Box 3 - Insight from case studies on up/re-skilling

The analysis of the different initiatives for up/re-skilling of the workforce in the four countries selected as case studies revealed a level of homogeneity in their attempts to address the issue that we did not find for the other areas of interest and attention. This is arguably because the EU has launched a Union-wide initiative, the Upskilling Pathways Strategy (UPS) in 2016, including guidelines and funding opportunities for all EU countries to promote up/re-skilling. A 2018 follow-up report found that Italy lacked any real interest in adult education, despite some attempts at addressing the issue. However, in its 2020 National Strategy for Digital Skills, Italy recognised the importance of adult education and continuous learning in the second of the Strategy's four goals, all of which together are intended to increase Italy's position in DESI rankings. Germany was implementing its own strategies way before the introduction of UPS. Finland was undergoing legislative changes to the educational apparatus,

following UPS guidelines. France was particularly focusing on very low skilled demographics. The insight provided by the case studies is that up/re-skilling is always necessary. In more digitally mature countries, like Finland, the skill shortage concerns higher-level digital abilities. The degree of digitisation of the country demands for a growing influx of ICT specialists. On the other hand, in countries where such transformation is still at its gestation stage, strategies are needed to up/re-skill a workforce that completely lacks any digital skills, thus the learning will focus on the basic level of digital proficiency. Targeting every country-specific demographic, ensuring that the least digitalised social groups have plenty of up/re-skilling opportunities, is an effective strategy, as opposed to broader, less context-specific adult education projects focused on training the general workforce without a nuanced look at which demographics need such training the most.

actions that allow people to acquire or improve new sets of skills that mix technical and non-technical aspects.

Figure 14 – Skills deemed most important for the digital transition and future competitiveness according to students



Source: Authors' surveys on digital skills and talent in the EU.

EU Policy Responses

A combination of policies, initiatives and instruments are present to address the need for skills development in the EU. The European Commission has targeted skills development through the new European Skills Agenda³⁹. It is a five-year plan supporting skills development for businesses as well as individuals and builds upon the actions of the 2016 Skills Agenda⁴⁰, which aimed to strengthen human capital, employability, and competitiveness. In its updated and revised version, the goals of the Agenda are strengthening sustainable competitiveness, ensuring social fairness – namely, access to education, training, and lifelong learning – and building resilience to react to crises, such as the COVID-19 pandemic. The new European Skills Agenda builds upon a variety of complementary strategies, such as the European Digital Strategy⁴¹, the Industrial and Small Medium Enterprise Strategy⁴², the Recovery Plan for Europe⁴³, and the Youth Employment Support⁴⁴. Existing funding instruments to underpin the Agenda are the European Social Fund Plus (€61.5 billion), the Erasmus+ Programme (€16.2 billion), Inve-

Strong careers and entrepreneurship possibilities are powerful motivating factors.

stEU (€4.9 billion), the European Globalisation Adjustment Fund (€1.1 billion), the European Solidarity Corps (€0.8 billion) and Digital Europe (€0.5 billion)⁴⁵. The European Skills Agenda is expected to impact the industry, endowing people with adequate skills that allow businesses to take full advantage of advanced technology. Furthermore, a skilled workforce enables sustainability, innovation, and productivity for all businesses, particularly SMEs as they grow and contribute to a successful digital and green transition.

Another cornerstone initiative in addressing the digital skills shortage in Europe is the Digital Skills & Jobs Platform. The platform is funded by the Connecting Europe Facility (CEF) and helps individuals and SMEs find relevant training and learning opportunities to sharpen their digital skills. Furthermore, the Digital Skills and Jobs Platform has an information-sharing function as it helps users stay up to date with the latest digital skills initiatives, projects, funding and good practices at the EU and national levels. The Platform offers a wide range of content and community features including:

- EU and national initiatives and actions in digital skills and jobs
- Training opportunities and career development support
- Good practices, expert advice, resources, and tools
- Data, research-based facts and figures
- Funding opportunities and financial instruments
- Thriving interactive community spaces
- News, opinions, and events from across Europe

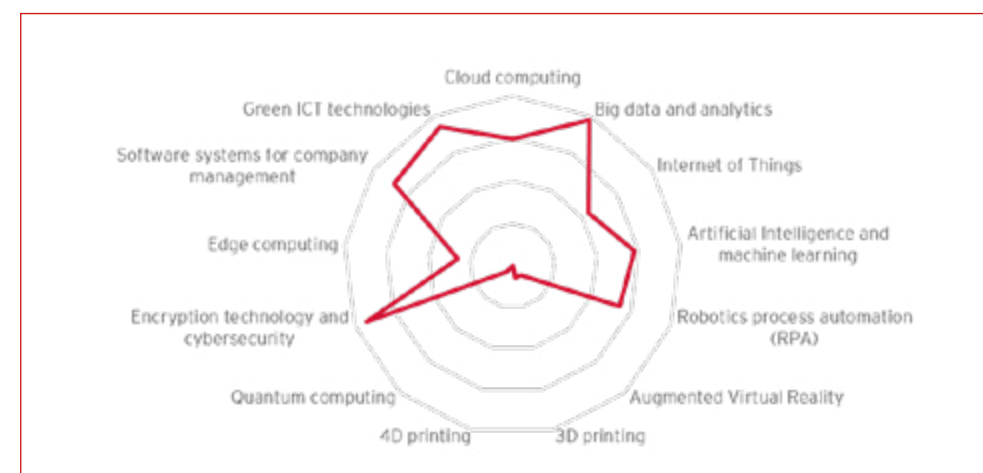
Regarding cybersecurity, the European Union Agency for Cybersecurity (ENISA) is the principle responsible body for activities within the EU, established in 2004. EU legislation in the area addresses measures to unify the region's fragmented cybersecurity strategy by strengthening MS security requirements, streamlining reporting obligations, and introducing more stringent supervisor measures and enforcement requirements. While this legislation falls short in directly addressing the cybersecurity specialist shortage, in 2020 ENISA established an Ad Hoc Expert Group on Cybersecurity Skills Framework⁴⁶. The Expert Group seeks to develop of a common language and taxonomy regarding cybersecurity skills in Europe, as well as to establish education, training, and employment standards within the field. ENISA has led the up-skilling effort in cybersecurity via the CyberHEAD platform, the largest validated cybersecurity higher education database in the EU and EFTA countries. Founded in 2020, CyberHEAD is "a main point of reference for all citizens looking to upskill their knowledge in the cybersecurity field"⁴⁷.

As an opensource platform, over 120 degrees and certificates related to cybersecurity are available.

Opportunities for Industry Action

Clarifying skills needs for firms will be critical to address the digital skills deficit. All actors agree that investing in talent and skills is critical for any ecosystem to flourish and remain competitive, particularly in today's fast-changing world. To be effective, investments must focus on current and (to the greatest degree feasible) future labour market demands, as well as designing and implementing future training, up/re-skilling measures. Another problem contributing to the digital skills training mismatch is the limited correspondence between skills taught to the students in universities or professional training courses and skills and competencies needed by industry. The analysis has shown how some of the leading technologies considered top priorities by industry (see *Figure 15*) are not always part of university curricula⁴⁸.

Figure 15 – Technologies identified as top priorities by industry in the next 3-5 years



Source: Authors' surveys on digital skills and talent in the EU.

Comparing the input from industry and student shows some differences between their impression of the most important skills and top priorities for the future, which cannot be ignored. One way to ensure full efficacy of the training initiatives is to supply policymakers, training providers, education

Cooperation between stakeholders is instrumental to fight the digital skills gap.

institutions and other relevant stakeholders in the training ecosystem with a clear idea of what skills are sought and desired by companies.

In most European countries there are organisations solely dedicated to monitoring the skill mismatch, a task which includes collection of data regarding, for instance, the most sought-after occupations and the most desired skill sets. Sometimes, this task is performed by a private company: in Italy, the Osservatorio delle competenze digitali (Digital Skills Monitoring Centre) is a private project funded and managed by the four main organisations of ICT-related companies.

Other examples include the partnership between Google and CEPS (Centre for European Policy Studies, a leading think tank on EU affairs) to compile the first comparative Index for Readiness for Digital Lifelong Learning (IR-DLL) in the EU. It provides recommendations and context around digital learning for policymakers, social partners, media and the general public.

Huawei's School of Female Leadership in the Digital Age is a good example of interdisciplinary learning path where horizontal skills are highly valued. The programme includes a Winter School, a Summer School and a Leadership Academy for European girls over 18 years old from the most diverse backgrounds without requiring any technical degree. The curricula combine hard skills, such as coding, and soft skills, such as communication and leadership. The themes of technology and digital revolution are discussed and explored in relation to other topics, such as inclusion, sustainability and ethics.



Another area where industry can play a role together with other actors in the ecosystem is market intelligence. Competences are changing quickly, following technological and organisational advancements, and there is a growing demand in the labour market to validate a wide range of competencies that are not always linked to formal education. Therefore, mapping the evolution of workers' competences and the needs and gaps in the labour market can be powerful tools for companies, universities and public authorities to identify skills gaps and opportunities for job creation and workforce planning.

HeadAI is a Finnish job tech company that uses artificial intelligence to map skills needs, seeking to ensure that companies and the labour market are supplied with relevant competencies. The company structures complex data into a visually comprehensible form with its unique AI system. The outcome of this process is an interactive "skills map of micro-competencies" which consists of detailed skills overviews of personal and professional competencies. The map recognises these and reveals new correlations, industry insights and up-to-date skills demand in Finland.

Finally, another area where industry can play a significant role is in the up/re-skilling of cybersecurity specialists in the EU. In cybersecurity, there are "constraints on those students who wish to acquire an all-round skill set in cybersecurity, as graduates have to specialise in either technical or societal cybersecurity issues, but not both"⁴⁹. While this issue partially ne-

eds to be approached within the education system for the sake of future students, industry has the opportunity to assist in the up/re-skilling of those 1.08 million cybersecurity specialists already in the EU.

As part of the 2021 DICYSCTECH project launched by Erasmus+ KA2, further training was offered to cybersecurity individuals in industrial fields⁵⁰. The purpose is to match higher education/vocational education and training ICT staff with informally educated IT students and adults for the purpose of up/re-skilling them with cybersecurity knowledge.

Encourage and support women in ICT

Key insights

- Failure to expose young girls to ICT and STEM from an early age could contribute to lower engagement throughout women's professional lives
- More women in leadership positions in ICT could encourage more female participation
- Work environments still do not facilitate female ICT retention

Underrepresentation of women in ICT as a part of the general lack of appropriately skilled workers and students has been echoed unanimously by respondents to the surveys. Respondents further elaborated on what they perceived as key factors contributing to the initial lack of and then low retention of women in ICT.

It is key to look at how women engage in ICT subjects from an early age. Our analysis of Eurostat data shows that, across the EU-27, differences in digital skill levels between men and women increase as educational attainment increases.

This indicates that men tend to study subjects that require them to develop digital skills at a greater rate than their female peers (see *Figure 17*). Among ICT-subject graduates across the EU-27, only 20% were women⁵¹.

The average percentage of employed ICT specialists across the EU-27 that was female was even lower than the percent of ICT graduates, at 18.5% in 2020. Among the EU-27 Member States, the highest percentage of women

employed as ICT specialists in 2020 was in Bulgaria with 28.2%, followed by Greece (26.5%), Romania (26.2%), Serbia (25.0%) and Finland (23.6%). The lowest percentages of women among the employed ICT workforce are found in Czechia (10.3%), followed then by Malta (10.7%), Hungary (12.3%) and Poland (15.0%).

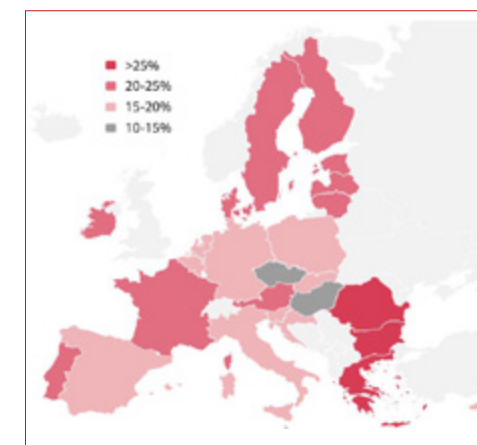
In response to the our survey, the lack of women was expressed as a persistent issue, while industry respondents reported difficulties in attracting and retaining women in ICT-related jobs (*Figure 18*).

Interviews suggested what might be drivers of the gender disparity – principally, the need for increased efforts to attract young girls at an early age.

Interview respondents agreed that young girls' low exposure to ICT fields may translate to low academic engagement and performance in the field. Lower engagement may lead to lower performance, and lower performance can discourage future engagement. At a young age, data collected suggest that performance in math and science is characterized by boys outperforming girls. The analysis of data collected in the TIMSS 2019 survey shows that, among 24 of the EU-27 member states plus the UK and Norway, boys consistently outscored girls in both maths and sciences⁵². There were only five instances where girls scored higher than boys in math in grade 8 and one instance in grade 4. In science, the results were more equal – though the most that girls outscored the boys was by 7.5% (Bulgaria, grade 4) while the most that boys outranked girls was as high as 20% and 19% (Hungary, grades 4 and 8). Early engagement and performance in particular subjects inform students' decisions as they continue with their academic and professional careers.

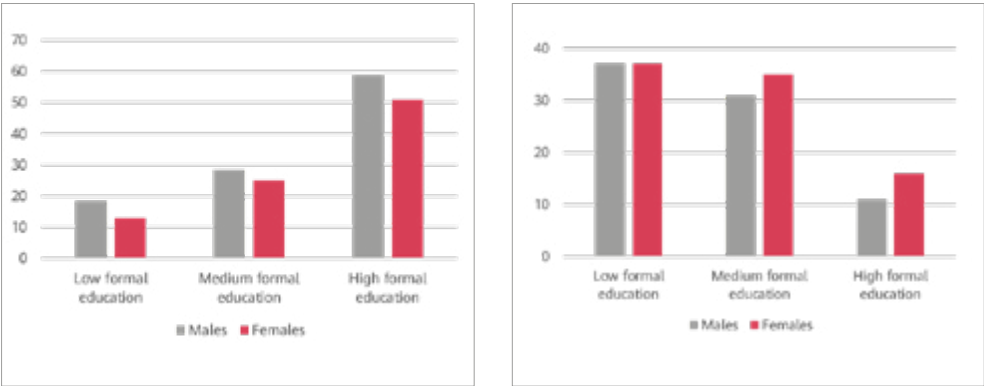
Student responding to the survey implemented for this report indicate the possibility to build strong job careers, pursue entrepreneurial ideas, as well as to contribute to a fast-changing world and society as top motivating factors for women in ICT. Women responded to the same survey that they wanted to be able to look at a company's leadership team and see other women represented. They expressed the desire to see other women succeed within the organisation – showing that they can, too. However, upon actually entering the ICT industry, women have fewer opportunities for

Figure 16 - Women as a percentage of employed ICT specialists (2020)



Source: Authors' elaboration of Eurostat dataset ISOC_SKS_ITSPT.

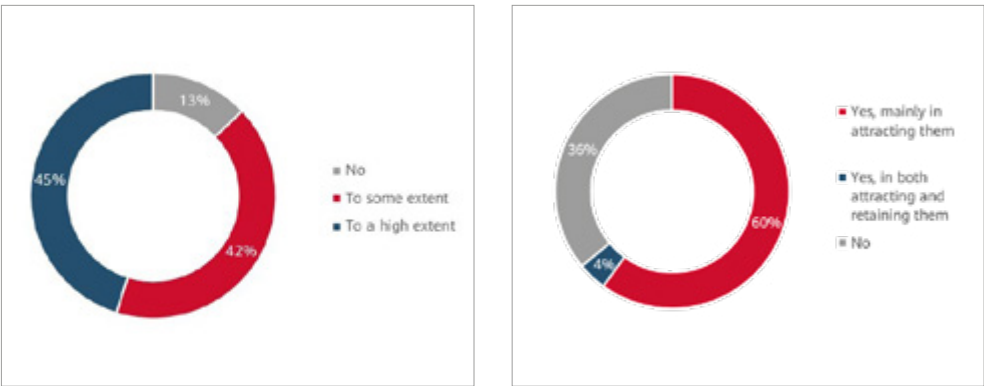
Figure 17 - Overall digital skill levels by sex and educational attainment – high overall digital skills (left) and low overall digital skills (right)



Source: Authors' elaboration of Eurostat isoc_sku data.

professional advancement and promotions – contributing to only 24% of leadership positions in ICT being held by women^{53,54}. More than half (55%) of women responding to the survey said they are not satisfied with female representation at senior and executive leadership levels, according to She Belongs in Tech, a 2019 study by TEKsystems⁵⁵. Over three-quarters of women reported being unsatisfied with the availability of female mentors to help them progress.

Figure 18 - Perception of surveyed students on the underrepresentation of women in digital/ICT jobs (left) and percentage of companies surveyed that reported difficulties in attracting and/or retaining women in ICT-related jobs (right)



Source: Authors' surveys on digital skills and talent in the EU.

EU Policy Responses

To address the digital gender gap, the European Commission launched the Women in Digital strategy in 2018⁵⁶. The strategy focused on three main actions: i) promoting digital skills and education, ii) challenging digital gender stereotypes, and iii) encouraging female entrepreneurship. To monitor progress, the EC also launched the Women in Digital Scoreboard, which is part of DESI. The scoreboard assesses MS performance in internet use and digital skills, as well as specialist skills and employment based on 13 indicators.

Another, brand-new initiative is Women TechEU⁵⁷. Launched in 2021, the scheme offers to female founders and entrepreneurs i) financial support to companies as individual grants of €75,000 to support initial steps in the innovation process, and the growth of the company, ii) mentoring and co-aching provided by the EIC Business Acceleration Services (BAS), under the new “Women Leadership Programme”, which include dedicated networking and pitching events, and iii) the possibility to participate in dedicated activities organised by InvestEU and Enterprise Europe Network. Moreover, the cardinal points of Europe’s Digital Decade⁵⁸ target the convergence between women and men in skills. Finally, the European Pillar of Social Rights Action Plan, launched in 2021, includes the target of having at least 78% of the EU population (aged 20 to 64) in employment, including by drastically reducing the gender employment gap.

Opportunities for Industry Action

The research conducted noted how difficult it is to fight the digital gender gap since it entails a shift in the cultural paradigm as to how society perceives the skills and roles of women, characterises ICT occupations and stigmatises ICT related subjects. Students were surveyed on their thoughts on the gender gap and potential remedies, responses to which indicated a series of possible actions that industry could implement to both attract and retain female talent, which are shown in Figure 19 and Figure 20. Encouraging and supporting female engagement in ICT in schools is crucial to this end. A change in mentality is more likely to take roots in young individuals, who have not been as exposed to current cultural stereotypes. This implies that private initiatives targeting women cannot, by default, be a short-term solution to the issue. Necessarily, the process will require years, or decades, with evidence of success becoming visible only in the future. Another feature of the gender gap worth mentioning is the fact that the

Need for increased alignment between industry’s vision and education’s mission.

many initiatives focus on soft skills such as leadership and confidence building, going beyond teaching only hard digital skills to women. Initiatives that promote women empowerment can play an important role in fostering the change of mentality that is needed, even if they do not deal with digital skills directly. Such efforts might include classes highlighting the impact of women in STEM fields, female leadership, and teaching about famous female scientists in history as role models, all of which can effectively combat

Box 4 - Insight from case studies on digital gender gap

Even in digitally mature countries like Finland, where the female population is slightly more skilled than the male population in terms of basic digital skills (the percentage of male and females with above basic digital skills is the same: 50%), there is an enduring imbalance in the ICT sector (only 23% of the total ICT employees are women, which is more than the EU average, of 19%, but still not aligned with Finland's leading results in most other indicators). This highlights that the problem of low female employment in this field cannot be resolved by only eliminating the digital divide in terms of skills. There are other drivers of the gender imbalance.

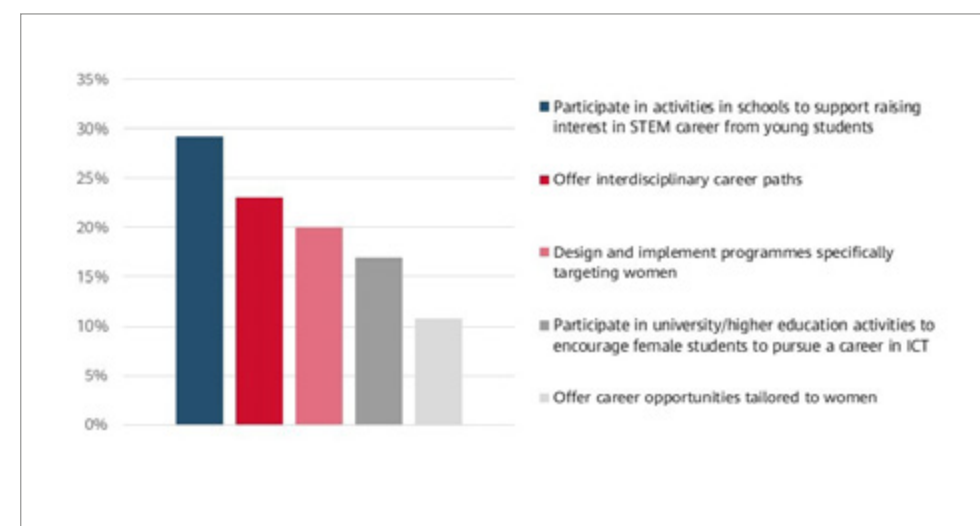
In Finland, many initiatives tackling the issue of women in ICT are private: Women in Tech Finland, Future Female and others. There is also the non-profit organisation Women4Cyber. The common feature of all these initiatives is that they focus on encouraging women to pursue career paths in ICT fields, such as programming or cybersecurity, rather than providing basic digital skill training, for which the female Finnish population is in relatively low need.

In Germany, many private initiatives address the issue of digital gender disparity. The main go-

vernment-promoted project is the Komm Mach MINT (Let's do STEM) focuses on providing career guidance to young female ICT specialists as well as to encourage female students to pursue a career in the field. In France, digital gender equality is addressed in the French National Plan for Digital Inclusion. The positive results are already visible, when comparing the two with countries where there has been little involvement of the government on the topic, like Italy for instance. Government involvement seems to be one of the most relevant factors addressing the gender gap. Alongside non-profit organisations, occasional summer schools or private projects, government involvement is the key factor in mitigating the digital gender gap.

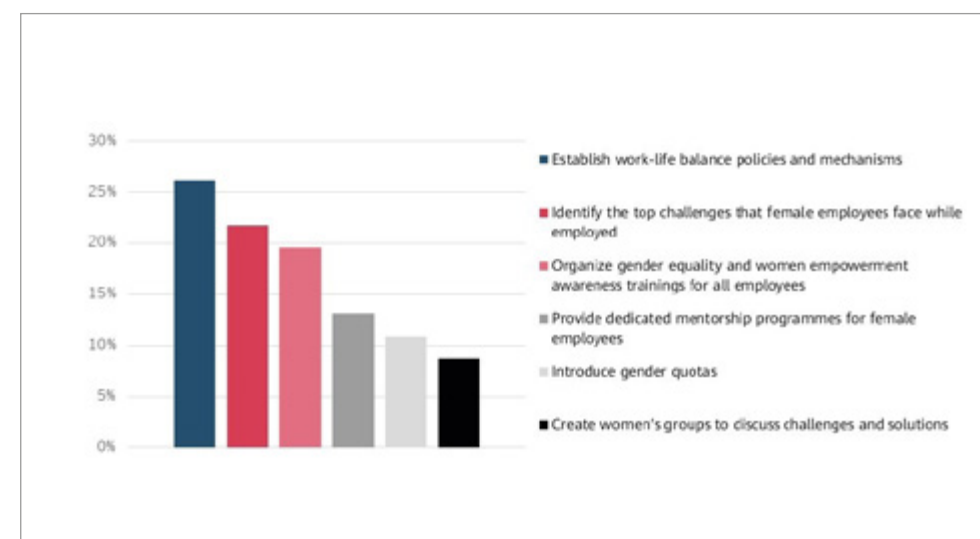
Italy is a good example of a country where the topic of digital inclusion has not been fully addressed until very recently. This has led to one of the largest gender gaps in terms of skills and female employment in ICT. The measures taken in Italy in the last few years are broad and not centralised in their organisation, mixing with all other initiatives falling under the aegis of the Digital Republic project.

Figure 19 – Actions for companies to attract female ICT talent suggested by students



Source: Authors' surveys on digital skills and talent in the EU.

Figure 20 – Actions for companies to retain female ICT talent suggested by students



Source: Authors' surveys on digital skills and talent in the EU.

stereotypes from a young age.

A further solution for companies attracting women in the digital sphere could involve interdisciplinary career paths. Mixing technical and non-technical competencies would allow companies to attract more women who do not necessarily have a STEM education. Interdisciplinary careers could encourage and enable women to work on ICT solutions while getting around the barriers of possible stereotypes.

Currently, national efforts are trying to address the gender gap issue with varying degrees of success. Countries like Estonia, Lithuania and Latvia have implemented strategies aimed at reducing the gender gap in this regard⁵⁹. Beyond national programmes, other examples are provided directly by industry and are presented below.

Our research has highlighted some examples of best practices on a national level:

- The Finnish Mimmit Kooda (Women Coding) initiative is a series of free and easily accessible coding workshops for women. Women in Tech Finland is another asset for Finnish women who want to start an ICT career
- In Italy, the Coding Girl project is a partnership between the non-profit organisation Mondo Digitale and the US embassy. It targets girls from middle and high schools, promoting events, training opportunities and round tables on topics such as digital inclusion and active methods to combat gender stereotypes
- In Germany Girl's Day, organised by the German government but with active cooperation of some of the biggest companies in the ICT field (e.g., Samsung), aims to provide young women with a more enticing and stereotype-free view of a career in ICT looks like. Relevant companies are encouraged to welcome female students to get them acquainted with that kind of work environment

Gender gap initiatives promoted by private companies are not overly abundant. Some free courses provided by Google deal with the topic of digital inclusion, but there is no learning path specifically designed to attract women towards ICT careers.

Microsoft announced in 2019 a series of digital skills boot camps to boost women involvement in the ICT field. Their partner network also includes

Women in Technology, a project that pursues digital equality via community events and webinars. The main flaw of these initiatives is that the training they provide is sporadic and not continuous. The occasional workshop or webinar may be helpful, but, as our primary research found, a more pervasive approach is necessary.

Huawei EU promotes the School for Female Leadership in the Digital Age, which oversees the organisation of a Summer School and a Winter School dedicated to Women and the tech sector. The selected applicants for these initiatives receive a full scholarship that covers the travelling expenses, making this a completely free but high-level training programme. Moreover, applicants do need not a background in STEM fields to be considered for the initiative.

Huawei Women Developers is even broader in its scope. It is a global programme to support women developers. This one is more focused on hard digital skills such as coding, but also more general assets, like networking opportunities and courses on career development. The training provided is continuous and free for any woman who successfully goes through the application process.



Drive collaborative digital skills ecosystems

Key insights

- Need for common terminology and language among universities, industry, and policymakers
- Actos call for more cooperation to build a solid ecosystem

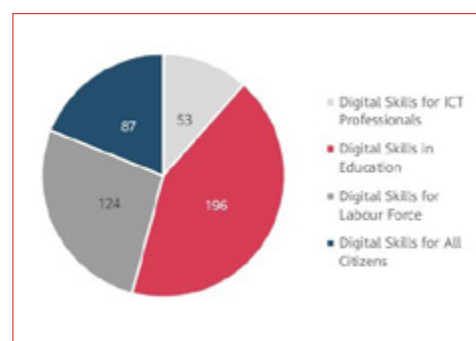
Cooperation between actors in the ecosystem is a key factor for the successful implementation of policies and initiatives, and digital skills are no exception. The European University Association found that the strategic boards of the top high-tech university campuses and science-parks⁶⁰ across Europe are consistently made up of public or government officials, private company representatives, and university staff members⁶¹. Yet, collaborative processes within European ICT ecosystems are limited in flexibility. Within European Framework Programmes (EU FPs), regulatory pressures

and administrative complexities result in EU-level orchestrators often choosing familiar partner organisations with which they have worked previously when considering new proposals⁶².

Measuring the number of coalitions and level of collaboration within and among Member States has its challenges. One example of EU-level cooperation is the Digital Skills and Jobs Coalition (DSJC) platform, which has provided private, public, and non-profit actors within MS to collaborate and share best practices since 2016. Across the EU-27, there are 626 member organisations within the DSJC platform. The member organisations have committed to 222 pledges involving 460 total initiatives thus far, each pledge lining up with at least one of the four DSJC key pillars⁶³. The numbers of national and cross-border pledges vary widely across Member States, due

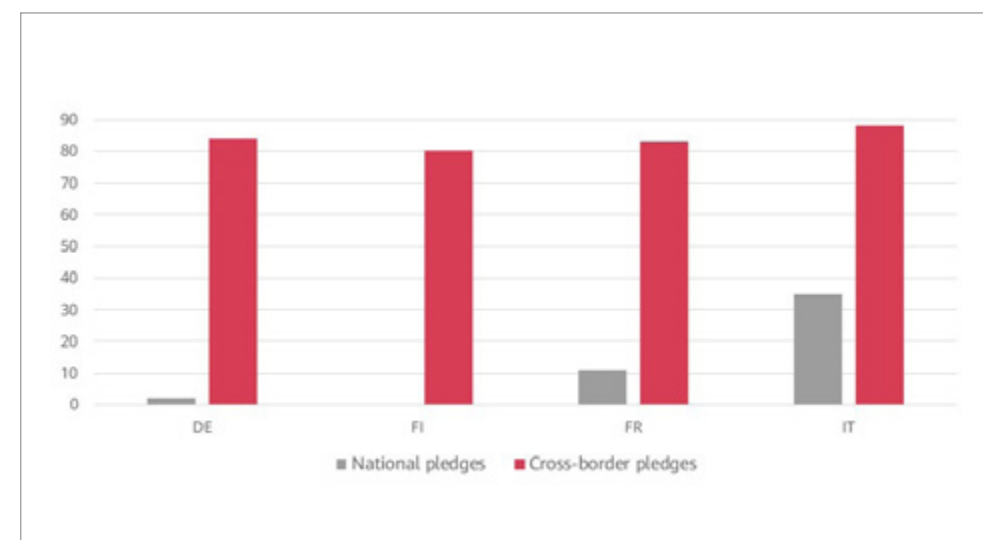
mainly to the outliers of Italy and Romania. The EU-27 average is 4 national DSJC pledges per MS yet most states report few to none. Italy has by far the most national DSJC pledges within the DSJC (34) while 19 of the 27 MS

Figure 21: Number of Digital Skills and Jobs Coalition initiatives, per DSJC pillar



Source: Authors' elaboration of EU Digital Skills and Jobs Coalition data.

Figure 22 - Number of national and cross-border pledges in Digital Skills and Jobs Coalition in select MS

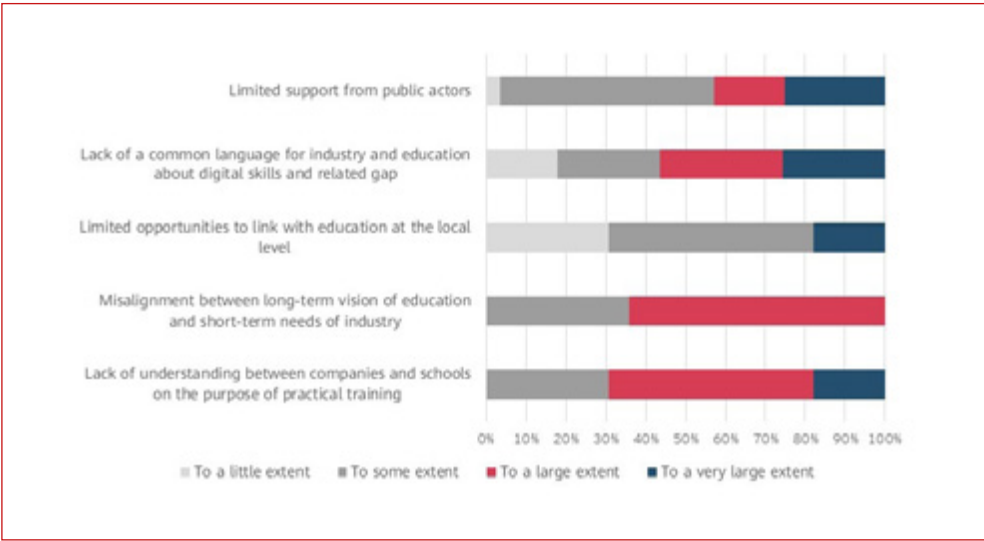


Source: Authors' elaboration of EU Digital Skills and Jobs Coalition data.

report having less than 5. Regarding cross-border pledges, the overall figures are much higher, with an EU-27 average of 78 cross-border DSJC pledges per MS. Among our four select MS, Italy leads with 86 (second overall in the EU to Spain, with 87), followed by Germany (82), France (81) and Finland (78). Difficulty in measuring the degree of collaboration in digital skills ecosystems is only an initial challenge. Responses to our survey reveal industry perceptions of further obstacles that stand in the way of cooperation with other actors, the correct implementation of actions and policies, and the improvement of the overall situation in the ecosystem (see Figure 23).

In particular, the top issues reported by industry concern the "distance" that exists between industry and education/training institutions. It relates to the need to align the short-term vision needs of industry with the long-term vision and mission of the education system, which has also difficulties in changing as fast as skills and technologies do. Moreover, companies highlighted that schools should be more aligned on practical training and application of skills acquired through education, as only this would fully prepare students for jobs and reduce the need for companies to train new employees. Companies also report the need for a better and common language for industry and education (as well as other actors) to communicate and cooperate.

Figure 23 – Main challenges reported by industry in integrating and cooperating with other actors in the ecosystem



Source: Authors' elaboration of EU Digital Skills and Jobs Coalition data.

EU Policy Response

The Digital Skills and Jobs Coalition, seen at the beginning of this section, is a cornerstone EU policies that aim to drive collaborative ecosystems⁶⁴. The initiative brings together MS, social partners, companies, education providers, and non-profit organisations that work at addressing the digital skills gap in Europe. Actions range from training job seekers, providing MOOCs, cutting edge training for ICT specialists, etc. The Coalition shares and promotes digital skills initiatives through the European Digital Skills Awards. Each year the EC spotlights initiatives that improve the digital skills of citizens, the labour force, ICT professionals, and women and girls through the European Digital Skills Awards. Member States can support collaboration between different actors in their country by bringing them together in national coalitions. Another EU initiative that drives collaboration is embedded within Digital Decade, as the EC will facilitate and accelerate both multi-country projects and international partnerships. Multi-country projects combine investments from the EU budget, including the Recovery and Resilience facility, from Member States and the private sector. Moreover, the modus operandi of multi-country projects is to support an interconnected and secure Digital

Box 5 - Insight from case studies on collaborative ecosystems



Among the indicators that have emerged from this study, collaboration is arguably the most dependent on country-specific cultural and social contexts. In Finland for instance, there is no official project that fosters collaboration between all the players involved in the digital skills training field. The specific features of Finnish society (e.g., almost all universities being public institutions) allow for the lack of a more cohesive collaboration strategies. Private initiatives on digital skills are still present, but they are not part of a broader, shared network of public and private projects. However, most our interviewees, even from Finland, stressed the importance of fostering partnerships between government and industry actors. Out of the four countries, Italy and France, which

are the ones who ranked lowest in DESI 2021 at the moment, have the most comprehensive project involving private actors: for both countries the main digital initiative of the country, respectively Repubblica Digitale and the Plan National pour un numérique inclusif), is a partnership between government, universities, municipalities and industry. Germany promotes collaboration within the ecosystem, but it is limited to particular areas such as Germany's 2017 Plattform Industrie 4.0 initiative, which focuses on integration of digital technology specifically in business models as well as value chains and product delivery, while not addressing some of the key areas of interest, like re-skilling or the existing workforce or encouragement to ICT education for students.

Single Market and address gaps in the identified critical capacities of the EU. To this end, the Commission has already identified a preliminary list of multi-country projects that includes investments in data infrastructure, 5G communication, high-performance computing, digital innovation hub, public administration, blockchain and digital skills.

In terms of international partnerships, the Commission seeks to promote its digital agenda globally to encourage convergence with EU norms and standards. Its toolbox for achieving the aforementioned goal includes regulatory cooperation, addressing capacity building and skills, investment in international cooperation and research partnerships. Potential international partnerships include 6G, Quantum, and the use of technology to fight climate change and environmental challenges.

Opportunities for Industry Action

Access to digital infrastructures should be increased and improved.

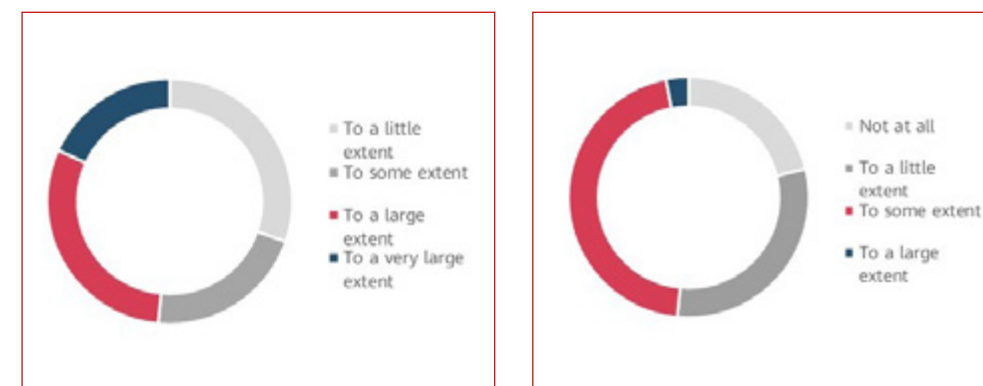
Cooperation with other relevant stakeholders in the ecosystem is emphasised as one of the most effective and preferable approaches between the experts who were interviewed for this report. Moreover, despite the challenges reported, industry representatives themselves largely agree that co-operation with other actors – in particular universities and other education/training partners – is one of the methodologies they consider best to strengthen the digital skills of the workforce (see Figure 24).

The cooperation should be initiated among and between different kinds of actors, limited not only to universities and vocations schools but with other companies and public actors directly as well.

A collaboration between industry and education, for instance, is crucial, and it can be structured differently: training can be offered to the student via their university but completed by the student alone in a fully digital and independent way; courses designed by companies can be added to existing university curricula; industry insight can inform the design of projects and laboratories. The research on which modality is preferred gave inconclusive results. It seems all approaches to the university-industry partnership are needed and desirable.

Some effort is required from universities to embrace constantly shifting needs and become more flexible either by allowing companies to offer their own training resources or by continuously adapting their curricula and other educational activities to change according to the needs at the moment. This can be difficult from a bureaucratic perspective, and some of our interviewees noted how universities seem to be always behind the latest stage of skills demand. If, as some suggested, modifying the curricula

Figure 24 – Industry responses over the effectiveness of cooperation with universities and vocational schools (left) and other companies (right) to strengthen the digital skills of the workforce



Source: Authors' surveys on digital skills and talent in the EU.

is not ideal, since the time required to do so is enough for any change to be outdated by the time of its implementation, universities should find other training opportunities, such as projects and labs, to be more flexible in terms of content and modality of training.



In 2020, Nokia announced plans to establish a 5G digital automation cloud at the University of Kaiserslautern (Technische Universität Kaiserslautern TUK) in tandem with Smart Mobile Labs AG. The three-year agreement between TUK and its partners will allow further research into 5G capabilities, specifically automation, logistics, construction, and agriculture.

Huawei ICT Academy offers ICT training in all the aforementioned modalities: interfacing directly with the student, or via the university through addition to existing curricula, and other blended modalities, where self-learning and learning in the classroom are combined. Huawei adds to its training also offering webinars and masterclasses which fulfil precisely this function.

In recent years, Italy has seen more initiatives dedicated to digital skills and born from the collaboration of various actors in the ecosystem, ranging from banks to universities to non-profit organisations. For instance:

- The Digital Connections Project is a project promoted by Save the Children with the support of various actors. The project is aimed at providing digital skill education to middle schoolers in areas where data indicates a more severe shortage of such skills. In the next years, more than 6,000 students aged 12-14 will receive basic digital skills training, in more than 100 schools across 15 different regions⁶⁵
- The Digital Futures Academy originates from a partnership between SDA Bocconi School of Management and Capgemini, consisting of free three-week intensive courses targeted at young STEM or economy graduates interested in the field of ICT consulting

In Finland, a joint venture was born from the collaboration of Nokia and the Tampere University of Technology, aimed at accelerating the introduction of the technology into Nokia's ReefShark chipset portfolio. This will also allow for technological innovation in the fields of machine learning, artificial intelligence and security hardware development.

The AI Elements MOOC was one of the most successful and internationally relevant Finnish training initiatives. The course was launched in 2018 and created by the University of Helsinki in cooperation with the private company Reaktor. The partnership is a perfect example of multi-actor collaboration in the digital skill ecosystem since it also involved policymakers: the Finnish government launched an initiative in 2019 to offer the course free of charge to all EU citizens with translations in every official EU language, reaching, as of today, more than 750.000 students.

Make IT Work is a programme launched by the University of Applied Sciences in Amsterdam, in cooperation with Dutch IT firms. The main goal of the project is to match the needs of the industry with university curricula. IT Training is provided to non-IT university graduates for new careers in the field, based on the current needs of the market. In parallel, the employers participating in the fast-track training partnerships gain access to the high-quality specialists they need to provide services and grow.

Invest in digitalisation of public services

Key insights

- Limited presence of digital infrastructure and digitalisation of public services are among the key obstacles for improving digital skills of the general population
- Lack of physical infrastructure blocks both creation of and participation in digital skills training
- Ensuring basic cyber-hygiene is practised throughout the population as part of basic digital skills

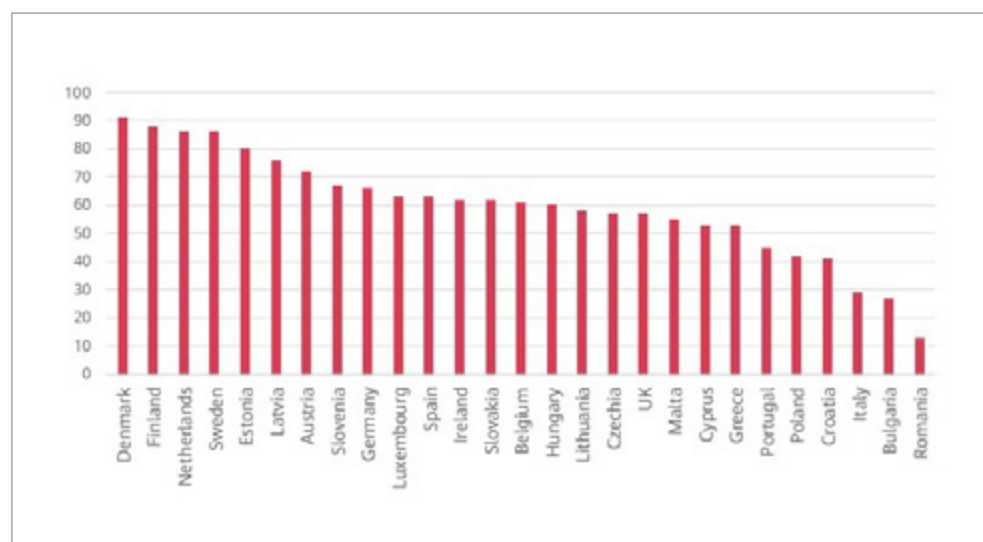
Over a decade ago, the United Nations reported that governments providing citizens with access to broadband coverage, in line with e-governance, would be key to solving the digital skills gap. Yet, as of 2019, nearly 15% of European households remain without access to fast broadband coverage due to a lack of digital infrastructure, while very high-capacity networks (VHCNs) are available in only 44% of households. The latter figure drops to 20% among rural households. The widespread level of digitalisation of public services throughout the EU is demonstrated by individuals' e-government activities online, such as declaring taxes, accessing official forms or documents, and interacting with public authorities online. In the EU-27, an average of 57% of individuals accessed e-government services in 2020. Both public and private institutions report a lack of digital infrastructure as a barrier to launching digital training initiatives⁶⁶. Lack of physical infrastructure blocks both creation of and participation in digital-skills training.

Digitalisation of public services and procedures is strongly associated with preparedness to adopt and integrate digital learning into the educational systems. Inversely, their absence is associated with lower levels of digital le-

The diffusion of e-services increases the importance of cyberhygiene.

arning preparedness. Germany, one of the EU-27's leaders in many indexes, is among the least digitalised of high-income countries when it comes to institutions and, correspondingly, ranks among the lowest for digital education preparedness. The limited presence of policy initiatives and prioritisation of digitalisation is likely a result of the broader cultural reluctance towards digital technologies in Germany. Among the EU-27, Germans ranked second-lowest in reporting that digital technology had a very positive impact on quality of life⁶⁷. Germany also ranked highest among OECD countries for concerns over online privacy and remains sceptical over cloud computing and big-data analytics⁶⁸.

Figure 25 - E-government activities of individuals via websites (2020)



Source: Authors' elaboration of Eurostat isoc_ciegi_ac data set, including: i_iugov12, i_iugov12if, i_iugov12fm, i_iugov1rt, i_iugovtax.

Among the EU-27, Denmark led the group with 91% of individuals engaging in e-government activities, followed by the other Scandinavian countries being Finland (88%), and both Sweden and the Netherlands (86%). Among the countries with the lowest level of individuals participating in e-government services were Romania (13%), Bulgaria (27%), Italy (29%) and Serbia (32%). Regarding broadband internet access at home, the Netherlands had the highest rate (97%), followed by Germany, Spain, and Finland (all 95%).

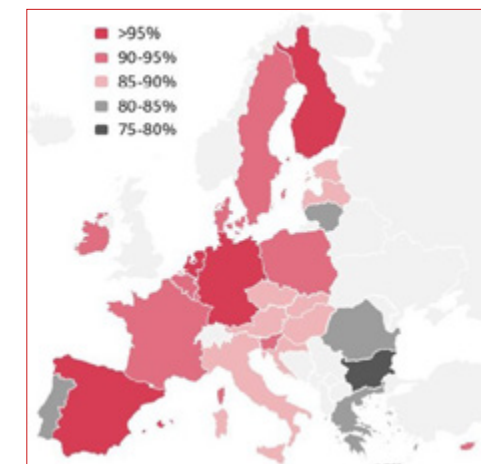


Bulgaria had the lowest rate of household broadband access (79%), with Greece (80%) Serbia (81%) and Portugal (82%) pulling in just ahead.

The research supports the significance of the connection between digital public services and digital skills. Appropriate investment is necessary to ensure that every European citizen has easy and affordable access to education and training in digital competences and the necessary digital infrastructure and broadband connectivity. The European Commission and Member States must work on a roll-out of the EU's digital strategy to deliver on infrastructure, support innovation and ensure sustainability. Indeed, our analysis of DESI indicators showed a high correlation (74%) between the level of digital public services and digital human capital across EU Member States. The only other DESI indicator more highly correlated with the level of digital human capital was the level of digital technology integration.

Playing an important role in the effective use of digital infrastructures and digital public services is the diffused presence of basic digital skills of the general public, among which are cyber hygiene and cybersecurity practices. The more digi-

Figure 26 - Percentage of households with broadband access (2020)



Source: Authors' elaboration of Eurostat dataset isoc_ci_it_h.

Box 6 - Insight from case studies on digitalisation of public services

The general trend in Europe is a newly discovered interest in virtual solutions for public services, mainly due to the COVID-19 pandemic, which forced governments and public authorities to find virtual ways to provide public services. Indeed, all of the case studies dedicated a significant portion of the recovery funds received by the EU to improving and evolving their digital infrastructures and interfaces to ensure a rapid transition towards virtual public services, especially in the health sector.

- The German Online Access Act (OZG) a programme responsible for digitising all administrative services, prioritizing health and crisis-related services.
- France is implementing AI in a major capacity as support for the digitalisation of digital public services, particularly regarding the tax administration, health and unemployment programmes.
- In Italy, €1.9 billion will be spent to build a secure and energy-efficient national cloud-based hybrid infrastructure (called 'Polo Strategico Nazionale') and to migrate local and central public administrations' IT systems to a cloud-based system.
- Finland is a European frontrunner for digitalisation of public services and the European recovery funds have been allocated to initiatives including e-health, implementing virtual diagnosis; employment services; digitalisation of public administration; public transport and the creation of a platform, Virtual Finland, which will offer a single gateway to electronic services of different ministries and agencies for persons arriving in Finland.

Furthermore, in France, in 2015, one of the main concerns was to provide all schools with an internet connection and every pupil in selected pilot secondary schools a laptop or a tablet. For more ambitious educational projects to be effective, the first step is to ensure that schools have sufficient digital infrastructure to implement them. Indeed, France followed up its 2015 plan for the proliferation of digital technologies in schools with the National Plan for Digital Inclusion, which focuses on, among other topics, improvements to teaching digital skills in school.

The same applies to Germany: The "Digital compact for Schools" is an initiative aimed at providing 40,000 schools with the necessary digital infrastructures (fast internet connection, tablets and other devices) to foster an upgrade of the techniques for the teaching of digital skills⁷⁰.



talised that public services become, the more opportunities that malicious actors will have to take advantage of vulnerabilities presented by technology and during the digital transition. A 2019 survey found that Europeans feel less capable of protecting themselves online compared to 2017 (down to 59% from 71%). In the last three years, over a third of European respondents had received a fraudulent email or phone call, over 10% had their social media hacked into, and 8% had fallen victim to ransomware⁶⁹. As a cyclical process, diffusion of basic digital skills and good hygiene practices also enables and facilitates further digitalisation of public services.

EU Policy Response

The digitalisation of public services and the need for digital infrastructure are two of the four cardinal points of the Digital Decade, as shown here below.



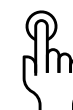
Secure and sustainable digital infrastructures

Connectivity: Gigabit for everyone, 5G everywhere

Cutting edge Semiconductors: double EU share in global production

Data - Edge & Cloud: 10,000 climate neutral highly secure edge nodes

Computing: first computer with quantum acceleration



Digitalisation of public services

Key Public Services: 100% online

E-Health: 100% of citizens having access to medical records

Cutting edge Semiconductors: double EU share in global production

Digital Identity: 80% of citizens using digital ID

In particular, by 2030 the EU has set specific targets to move all key public services 100% online, have 100% of EU citizens have online access to medical records through e-Health, and shift to a coverage of 80% of citizens who use the digital ID.

In April 2021, the European Health and Digital Executive Agency took over the capacities of the now-defunct Connecting Europe Facility (CEF) Telecom in the form of the Connecting Europe Facility - Digital. The programme manages a €1.5 billion budget from 2021-2027 to facilitate intra-MS communications between public administrations, businesses and citizens via the deployment of digital service infrastructures as well as national, regional, and local broadband networks. Calls for project proposals are open to public actors, private organisations, and public-private partnership proposals.

Opportunities for Industry Action

Regarding digitalisation of public services and expansion of digital infrastructure, there are several areas in which industry has already begun to support the digital-green transition.

In 2020, Nokia's 5G4KMU project deployed a 5G private network across five German research institutes in partnership with the Baden-Württemberg Ministry of Economics, Labour and Housing. The project seeks to incorporate 5G into the state-level execution of the broader federal level Industry 4.0, facilitating demand-oriented networking, higher bandwidth, low latency, and a greater number of connections. Targeting small and medium-sized enterprises, the 5G4KMU project also educates businesses on how to use and take advantage of 5G.

Huawei has committed to investing €20 million in a 5G Partner Innovation Programme to fund and accelerate the proliferation of 5G technologies in the United Kingdom and European Union. Huawei is in the process of designing a 5G antenna specifically tailored to accommodate Europe's fragmented radio frequency spectrum, one of the most peculiar and challenging features of the European digital infrastructures landscape.

The Connected Europe initiative was launched by Friends of Europe, a leading think tank on European issues. The objective is to help EU Member States fulfil their digitalization targets. In particular, the initiative aims at boosting Europe's connectivity to foster a digital transformation, making European economies and societies more resilient to future shocks, and more competitive on the global stage. The initiative underlines also the importance of digital infrastructures, which is one of the main obstacles to digitalisation of public services.

Obtaining an adequate level of basic cybersecurity and cyber hygiene among the population to prevent malicious actors from taking advantage of citizens is another key element to the correct and full implementation of digital infrastructure and public service offerings.

In France, the Guide Des Bonnes Pratiques De L'informatique⁷² provides SMEs with an operational guidebook with 12 steps on cyber hygiene and cyber security to implement. The guide is aimed at helping non-ICT specialists implement

cybersecurity and cyber hygiene practices in their operations, concerning topics such as client/customer communications; internal communications; the processing, transfer, and storage of data. This is a distillation of the longer 40-step guideline produced by the National Agency for the Security of Information Systems (ANSSI).

Across Europe, Huawei works with cybersecurity education organizations to operate the SmartBus project, which aims to protect young people online by instilling good cyber hygiene practices throughout the younger generation. Huawei's SmartBus is an interactive, mobile digital classroom that teaches children aged 11 to 15 about the potential dangers of the Internet through interactive lessons and games. The programme was launched in the Flemish town of Sint-Truiden in Limburg, Belgium and in the Netherlands in 2019. By the end of 2020, Huawei's SmartBus had visited 126 different schools in five European countries and reached more than 25,000 children.



Notes

21. "Navigation." Persons with ICT Education by Labour Status - Products Datasets - Eurostat.
22. Eurostat LFSA_EGISED.
23. The share of enterprises the lack of ICT qualifications from education and/or training is not provided in the Eurostat dataset for Italy.
24. European Commission/EACEA/Eurydice, 2021. Teachers in Europe: Careers, Development and Well-being. Eurydice report. Luxembourg: Publications Office of the European Union.
25. Hopbach, A. and Flierman, A., 2022. Higher education: a rapidly changing world. [online] Enqa.eu.
26. This was analysed by reviewing the curricula offered by the top five universities (according to the QS ranking in 2021) in the four countries of focus for this report (DE, FI, FR and IT).
27. Consortium of Institutions for Development and Research in Education in Europe. Balancing Curriculum Regulation and Freedom. 2013.
28. Leading the way into the age of artificial intelligence - Final report of Finland's Artificial Intelligence Programme 2019, Publications of the Ministry of Economic Affairs and Employment Competition and consumers • 2019:41.
29. Strategia Nazionale per le competenze digitali, Piano Operativo – 23 December 2020.
30. Source: European Commission, European Skills Agenda, Employment, Social Affairs & Inclusion.
31. Source: European Commission, European Education Area - Digital Education action Plan.
32. The original plan was revisited in 2020 to respond to the great leap forward in digitised education, training, and work, catalysed by the Covid-19 pandemic.
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35. Among students replying to the question, 54% agreed (partially or fully) that companies are not fully aware of the lack of digital competences/digitally skilled workers (31% replied "I do not know"), while 69% agreed (partially or fully) that EU companies are not fully aware of how to address the lack of digital competences/digitally skilled workers (23% replied "I do not know").
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03. Conclusions

The digital transformation and green transition have a far-reaching impact on the EU and its labour market. They represent a major opportunity for the EU's competitiveness; however, they bring challenges that need to be addressed accordingly. In particular, the EU needs to focus its efforts in order to ensure that the workforce – and all citizens – obtain and improve the appropriate digital skills. The digital skills gap hampers EU's competitiveness, growth and ability to innovate.

In this study, we have investigated and drawn conclusions on the key factors that contribute to the digital skills gap in the EU and what industry can do to help address it. As identified, the path forward to address challenges presented by technological change, automation and decarbonisation involves not only investing in technology but also in people. As the digitalisation process continues to accelerate, demand for the already limited supply of ICT talent will increase, making competition for talent fiercer. The analysis conducted suggested how several factors play a part not only in shaping the effects of the digital skills gap across the EU but also in the very challenges that industry is facing.

- 1. Improve and increase educational opportunities.** There is room for improvement in the transition from education to industry with the right mix of skills and the necessary practical experience to use them. While this is one of the main challenges for industry, it opens up the possibility for companies to fill the gap by designing new learning opportunities or university curricula in line with their needs, as well the opportunity to create ad hoc platforms and tools (such as internal academies) that can match trending technological developments with industry's needs. An increased role of industry in the design and provision of training will make education and training increasingly available and accessible, especially when targeting not only employees but all citizens. Moreover, the design and delivery of digital competency education and training must respect cultural variety and expression, be ethical, and not discriminate on any basis (e.g. age, race, gender, financial condition, disability). To represent how people live, study, and work, as well as to ensure flexibility in the fruition of education and training opportunities, different learning methodologies (blended, on-line, in-person), learning styles (visual, interactive), and learning contexts (classrooms, workplace) must be accommodated in the design and delivery of education and training.



Finally, any education and training opportunity must be underpinned by strong quality assurance. All actors work together to make sure that providers adhere to certain quality standards, certifications for the successful completion of a course or a learning path are officially recognised. To this end, the introduction of a 'European Digital Skills Certificate' will be instrumental, supporting quality, common approaches and recognition of digital competence certifications in the EU.

- 2. Prioritise talent within companies: up/reskilling.** There is still a large share of companies without a clear up/reskilling strategy. Nonetheless, companies, have a unique role to play not only in designing and implementing up/re-skilling initiatives but also in creating new career paths where technical skills are mixed and applied together with horizontal competences, allowing for maximised return on investment of the newly implemented digital technologies. In order to design the right mix of training initiatives and shape future career paths, companies and all other actors need to be aware of how skills are evolving, as well as what skills are available or not in the company and in the labour market. Companies need to grasp the current situation of employees' skill level in

a timely and accurate manner, for instance with regular internal skill assessments, talent inventory exercises. On the other hand, industry needs to actively participate – if not lead – in assessing the current situation of digital skills gap, and in forecasting future needs in the labour market, to provide targeted guidance for new talent development initiatives.

Based on the actual and future needs, digital competence courses must provide a comprehensive learning experience that includes skills that promote employability and professional advancement, helping the transition of existing talents to digital-skilled positions and achieve sustainable development of talents. The education and training offered must therefore be relevant, holistic, dynamic, and lifelong.

The combination of technical skills with more horizontal, transferrable non-technical skills, as the analysis has shown, are becoming increasingly important not only for companies but for future employees as well. The combination of these skills not only enables companies to better grasp, apply and steer change, but also allows the creation of new career paths, responding to the dynamics of a fast-changing environment. Sustainability as a crucial facet of digital competence should also be emphasised in courses.

3. Encourage and support women in ICT. Women represent an untapped pool of talent that has not been given adequate opportunities to thrive. By creating the right conditions, industry has the unique opportunity to reduce the need for digitally skilled workers while reducing the gender imbalance in the labour market and to provide female students, workers and entrepreneurs with the opportunity to become a strong part of the workforce. The strong presence of role models of women in ICT leadership positions, the opportunity to pursue entrepreneurial ideas as well as the possibility to define new career paths that mix technical and horizontal skills are all elements that can be put in place to this end.

4. Drive collaborative digital skills ecosystems. Neither public nor industry initiatives alone can effectively and consistently create a strong talent development system. A robust digital ecosystem needs to be built on the cooperation between multiple parties, as EU policies have underlined, providing opportunities for different actors to work together and find new solutions. The stakeholders interviewed unanimously pointed to the collaboration between public and private actors as the best method to reach that goal.

Digital competence development necessitates an “all-government” strategy that encompasses digital competence development in areas such as

employment, the labour market, education and training, social services, and economic growth.

Governments, industry, education and training providers must team up to gather and share information about current and future needs for digital talent. Dedicated governance systems might be put in place to govern the process, ensuring its effectiveness and sustainability, as well as to reduce the fragmentation of efforts in training and development of digital skills, fostering coherent and synergistic strategies.

To enable the timely development of holistic digital skills, stakeholders from industry, society, education and training must collaborate also on the design and delivery of courses and services, as well as the development of procedures. In particular, the modalities of industry-education cooperation need to be systematically explored and continuously updated, to establish the most effective cooperation methods depending on both the characteristics of the relevant context and its dynamics. While industry becomes an actor in the definition and provision of education and training, universities actively participate in the definition of future ICT industry skills models and pathways, to guide the development of teaching and research in the field.

In order to do so, all actors must use a common terminology and language, developing a common reference model to guide them in the process. The presence of DigComp as a EU framework provides already a solid basis for developing and understanding digital competences. However, this model could be further developed in order to take into account a wider range of competences which, as presented in this report, enable actors to fully capture and steer innovation opportunities.

Finally, as mentioned, the cooperation of various stakeholders is instrumental to the creation of digital skills certification systems, which will be another powerful tool to guide the labour market to select talents objectively and reasonably in a timely manner.

5. Invest in digitalisation of public services. The digitalisation process of any individual country – and the whole EU – goes through the digitalisation of its society, meaning an increased uptake of basic digital skills among the population, and increased presence and use of digital public services. Moreover, digital public services require a proliferation of efficient digital infrastructures, which are also an essential part of the process of digitalisation in a country. Industry actors can provide the means to ensure that infrastructural upgrades are suitable to the country’s needs, as well as work together with other actors to improve the access to basic digital skills training courses for the general public, in order to improve

digital literacy in society and facilitate the use of digital public services. The research has also identified important areas for further analysis. In particular, a stronger, deeper assessment of the coverage of existing policies, initiatives and mechanisms at the EU level should be carried out, in order to identify possible shortcomings and areas for further action. Further, an estimation of the costs that all actors (i.e. governments, companies, education and training providers) would need to bear, including the elements stemming from our analysis should be implemented. Addressing the current challenges - posed by COVID-19 in tandem with the disruption posed by technological change - requires renewed public service innovation, for the benefit of all citizens, whose level of digital skills must continue to grow. The extent to which the digital skills gap affects the competitiveness and development of companies, countries and regions is still difficult to fully grasp. However, this report has sought to demonstrate how industry - together with the other key actors - has a strong role to play in shaping the current and future ecosystem, in order to reinforce the EU's capacity to address the digital skills gap, improve their competitiveness, and reach their strategic objectives for the next decade.

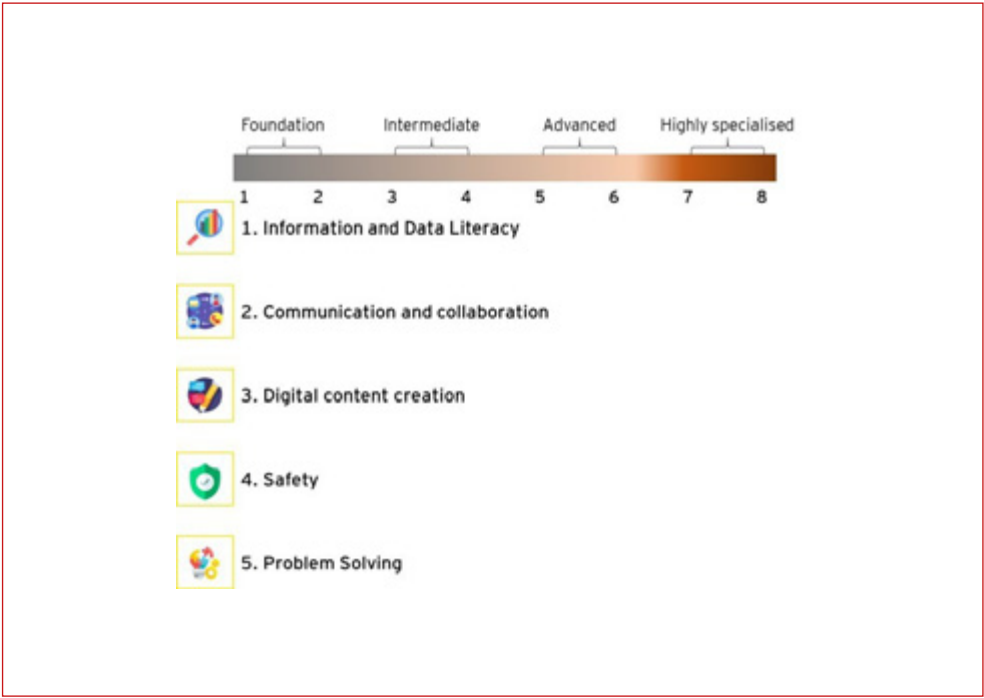


04. Annexes

Definition of digital skills in the DigComp2.1 framework

DigComp 2.1 is a further development of the Digital Competence Framework for Citizens. Based on the reference conceptual model published in DigComp 2.0, the framework presents 8 proficiency levels for five competence areas.

Figure 27 – DigComp 2.1 competence areas



Source: Authors’ elaboration of DigComp 2.1 from the JRC Publications Repository.

The European Digital Competence Framework for Citizens is developed by the Joint Research Centre as a scientific project and with intensive consultation of stakeholders.

Table 3 - Definition of Digital Skill Types and Proficiency Levels.

Digital skill type	Description	Proficiency levels
Information skills	Those that allow an internet user to identify, locate, retrieve, store, organise and analyse digital information, judging its relevance and purpose	Those with basic information skills could carry out one of the following tasks whereas those with above basic skills could carry out more than one: <ul style="list-style-type: none"> Copy or move files or folders Save files on Internet storage space Obtain information from public authorities/services' websites Find information about goods or services Seek health-related information
Communication skills	Those that allow an internet user to communicate in digital environments, share resources through online tools, link with others and collaborate through digital tools, interact with, and participate in communities and networks, cross-cultural awareness.	Those with basic communication skills could carry out one of the following tasks whereas those with above basic skills could carry out more than one <ul style="list-style-type: none"> Sending/receiving emails Participating in social networks Telephoning/video calls over the internet Uploading self-created content to any website to be shared
Problem-solving	Those that allow an internet user to identify digital needs and resources, make informed decisions as to which are the most appropriate digital tools according to the purpose or need, solve conceptual problems through digital means, creatively use technologies, solve technical problems, update one's own and others' competences	Those with basic problem-solving skills could carry out one or more activities from only list A or list B whereas those with above basic skills could carry out at least one activity from both list A and list B <p>List A – Problem-solving</p> <ul style="list-style-type: none"> Transferring files between computers or other devices Installing software and applications (apps) Changing settings of any software, including operational system or security programs <p>List B – Familiarity with online services</p> <ul style="list-style-type: none"> Online purchases (in the last 12 months) Selling online Used online learning resources Internet banking
Software skills (for content manipulation)	Those that allow an internet user to create and edit new content (from word processing to images and video); integrate and re-elaborate previous knowledge and content; produce creative expressions, media outputs and programming; deal with and apply intellectual property rights and licenses.	Those with basic software skills could carry out one or more activities from list A but none from list B whereas those with above basic skills could carry out at least one activity from list B <p>List A</p> <ul style="list-style-type: none"> Used word processing software Used spreadsheet software Used software to edit photos, video, or audio files <p>List B</p> <ul style="list-style-type: none"> Created presentation or document integrating text, pictures, tables, or charts Used advanced functions of spreadsheet to organise and analyse data (sorting, filtering, using formulas, creating charts) Have written a code in a programming language

Source: Eurostat TESPR_SP410.

Indicators

We have considered the following Eurostat indicators in the sections provided in Table 4 below to indicate and qualify the digital skills gap.

Table 4 - Mapping digital skills supply to digital skills demand indicators

Digital skills supply indicator	Digital skills demand indicator
% of EU population with low and basic proficiency in general digital skills	% of enterprises providing digital skills training for personnel
% of EU population with above basic digital skills	% of enterprises providing digital skills training for ICT specialists
Number of unemployed ICT specialists	Number of employed ICT specialists Number of vacancies for ICT positions
% of labour market with ICT background	<ul style="list-style-type: none">% of enterprises recruiting ICT specialists% of enterprises experiencing difficulties in hiring ICT specialists

Source: Authors' elaboration.

Starting with the digital skills supply indicators, the percent of the EU population with low, basic and above basic proficiency in general digital skills is a composite indicator based on the DigComp framework for selected activities related to internet or software use performed by individuals aged 16-74 in four specific areas (information, communication, problem-solving, software skills).⁷²

We use these data to indicate digital skills mismatch, as defined above, where it is possible to ascertain the level of digital skills required for the respondents' occupations. For instance, we expect that ICT professionals need at the very least basic general digital skills. To correct digital skills mismatch, enterprises may provide digital skills training (among other initiatives) either for their personnel or ICT specialists. As such, we take the percentage of enterprises providing such training as an indicator of the digital skills mismatch on the demand side.

For the digital skills shortage, we rely on indicators such as the percentage of the labour market with an ICT background as well as the number of unemployed ICT specialists for the supply side. For the demand side, we look at the number of ICT job vacancies and the number of employed ICT specialists. Furthermore, we investigate the percent of enterprises recruiting ICT specialists, those that have difficulty in recruiting ICT specialists and the reasons for these difficulties.



Sectoral analysis

In this section of the report, we cover the following sectors: automotive, cloud and operational systems, digital energy and sustainability. For data-collection purposes, these sectors were identified using the NACE Rev 2 statistical classification of economic activities, as presented in the table below.

Table 5 – Definition of NACE Rev2 sectors in scope

NACE sector	Activities
Manufacturing	Manufacture of computer, electronic and optical products
	Manufacture of motor vehicles, trailers and semi-trailers, other transport equipment
Energy	Electricity, gas, steam, air conditioning and water supply
Information and Communications	ICT sector
	Telecommunications Computer programming, consultancy and related activities, information service activities

Source: Authors' elaboration.

We can see that, on average between 2012 and 2020, the majority of enterprises across the EU-27 that provide computer programming, consultancy and information services provided digital training to their personnel, more than twice as many as the share of motor vehicle manufactures or energy and utilities suppliers. The average share of enterprises that provided digital

skills training across the EU-27 per focus sector is also proportional to the average share of enterprises that employed ICT specialists per focus sector. This means that the focus sectors where the share of enterprises offered more digital skills training were also those that hired more ICT specialists (and vice versa).

Figure 28 - Average share of EU-27 enterprises that offer digital training, that hire ICT specialists and that mainly outsource ICT functions per focus sector (2012-2020)⁷³



Source: Authors' elaboration of Eurostat ISCO_SKU data.

On the other hand, these trends are inversely proportional to the average share of EU-27 enterprises that mainly outsource ICT functions to external suppliers. Focus sectors that provide relatively less digital skills training and that hire fewer ICT specialists consequentially outsource their main ICT functions to external suppliers at a higher rate. These trends have remained rather stable during this period (2012-2020). The average annual growth rates for all three indicators do not surpass two percent and most are closer to zero. It is interesting to see that in the auto-manufacturing sector, outsourcing of ICT functions outpaces both training in digital skills as well as the hiring of ICT specialists. This is true in energy and utility services as well where, however, training in digital skills outpaces hiring of ICT specialists. These trends are contrasted with the other sectors where the hiring of ICT specialists is followed by training of digital skills and then outsourcing of ICT functions.

Case Studies

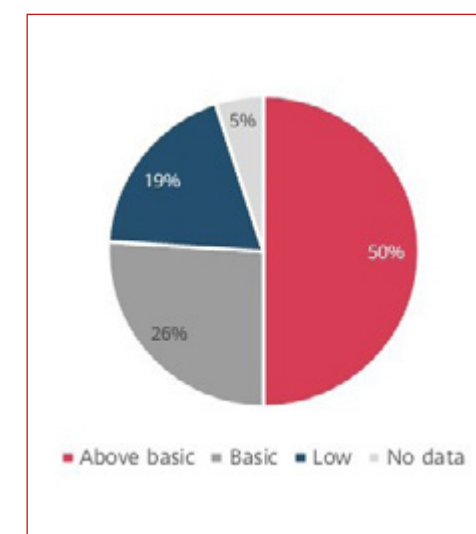
Finland

Key statistics

Finland's statistics are outstanding in almost every regard and capture the situation of a country where the digital transition is in full bloom and the digital maturity of the population finds no match anywhere else in the Union. Finland had the highest percentage of ICT specialists in the labour force in Europe in 2020 (7.6% of the total workforce, against an EU-27 average of 4.3%). The country ranked first on this indicator from 2011-2020, the only two exceptions being 2018 and 2019, in which it ranked second. 50% of Finns had above basic overall digital skills (tying with the Netherlands for first among EU members). An additional 26% of Finns had basic digital skills, bringing the total percentage of citizens with at least basic skills to 76%, twenty percentage points ahead of the European average. Finland's national strive to continuously provide new education and training opportunities was proved successful.

As an example of such strive, consider the area of attention of the need for training, up-skilling and re-skilling. In 2020, Finland ranked first in the whole European continent for the percentage of enterprises (10 employees or more and without considering the financial sector) that provided training to develop or upgrade ICT skills of the personnel (38%). Finland has a strong lead in this indicator, being 5 percentage points ahead of the countries in second place (Belgium and Norway, both 33%)⁷⁴. In 2018 Finland and Norway were the two countries in the Eurozone with the highest percentage of individuals who obtained their ICT skills via training paid or provided by their employers (27%, against the EU-27 average of 8%)⁷⁵. Despite its high performance, Finland is experiencing the skills gap with an intensity similar to the other European countries: in 2020 14% of medium enterprises and 30% of large enterprises experienced the issue of hard-to-fill ICT vacancies.

Figure 29 - Percentage of Finnish population with low, basic, or above basic digital skills.



Source: Authors' elaboration of Eurostat ISOC_SK_SDKL_I data.

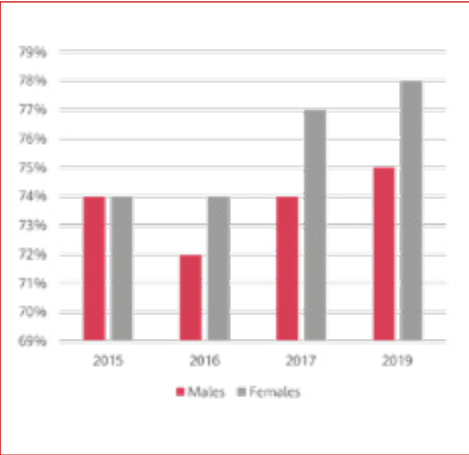
The main reasons behind this shortage were lack of applications, lack of applicants with relevant ICT qualifications, lack of applicants with relevant work experience and applicants whose salary expectations were too high. The table below displays the relevance of these causes of ICT specialist shortage, in relation to the size of the enterprises in Finland.

Table 6 - Percentage of Finnish enterprises reporting the following causes of ICT specialists’ shortage

Causes of difficulties in ICT recruiting	Finnish enterprises by size		
	Small	Medium	Large
Lack of applications	4%	14%	30%
Lack of relevant ICT qualifications	4%	8%	17%
Lack of relevant work experience	4%	12%	24%
Excessive salary expectations	3%	7%	20%

Source: Authors’ elaboration of Eurostat ISOC_SKE_ITRCNR2 data.

Figure 30 - Percentage of Finnish population with at least basic digital skills, by gender



Source: Authors’ elaboration of Eurostat ISOC_SKE_ITRCNR2 data.

Finland’s record is exceptional in many areas of attention, but encouragement and support of women is where the distance from the rest of Europe is more remarkable. In Europe, the percentage of male individuals with at least basic skills (Eu-27 58%) is slightly superior to the percentage of female individuals with the same level of digital proficiency (EU-27 54%). In Finland, the trend is reversed: the female population is generally slightly more skilled than the male population. In 2019, 78% of the female citizens had at least basic digital skills compared to 75% of male citizens. The gap widens for specific age groups: for the population aged 16-24, 92% of females scored at least at basic level while 87% of males managed to do so. It is one of the few examples in Europe of a reversed gender gap in ICT professions. Finland’s exceptionality with regard to this area

of interest is, however, limited to the skills of the general population. In another indicator, for instance, the percentage of women ICT specialists, Finland still scores above average, but with a smaller margin: in 2020 some 23% of all Finnish ICT specialists were women, against an EU average of 19%. Finland’s relatively worst performance, when compared with the excellence in every other area of attention and opportunity, is institutional preparedness and digital infrastructure. In 2020, only 57% of Finnish households have access to broadband coverage. Compared to the European average (77%), this may be the single indicator in which Finland performed worst and farther from the rest of the Union. As a result, Finland’s ranking in the “connectivity” indicator of the DESI report is 13th, while it ranked 1st for “human capital” and “integration of digital technology”. However, with regard to the indicator “public digital service” which also captures institutional preparedness, Finland ranked 3rd.

Policy response

The Finnish initiative addressing the area of attention of the need for training, upskilling and reskilling is one of the most effective and ambitious in Europe. In 2019 the Finnish government launched the Continuous Learning Reform. The reform targets working-age adults and seeks to respond to upskilling needs arising from changes in the world of work. As part of the reform, the Finnish government aims to create opportunities for everyone to upskill and reskill proactively and consequentially have a competitive labour force that supports sustainable growth and innovation, with an emphasis on digital skills. With regard to educational opportunities, the Ministry also proposed a reform of the education system so that it can provide high-quality AI courses across all sectors of the Finnish population (including the elderly). One of the key educational initiatives is the AI Elements massive open online course (MOOC). Given the outstanding performances in digital proficiency of the general population, Finnish programmes for providing ulterior educational opportunities are decisively different from similar programmes in less digitally mature countries. In Finland, there is no longer the need to teach students or the elderly basic digital skills. Thus, Finnish initiatives focus on more advanced topics, for instance, familiarisation of the population with the fundamentals of AI. The aspect of collaboration within the ecosystem is not addressed explicitly by reform or policy, but it can be seen at work in the plethora of initiatives sponsored by the private sector. In particular, some of the most relevant projects involving women’s support and encouragement in the ICT field are private: Women in Tech Finland, Future Female, Mimmit Koodaa (Women Coding).

France

Key statistics

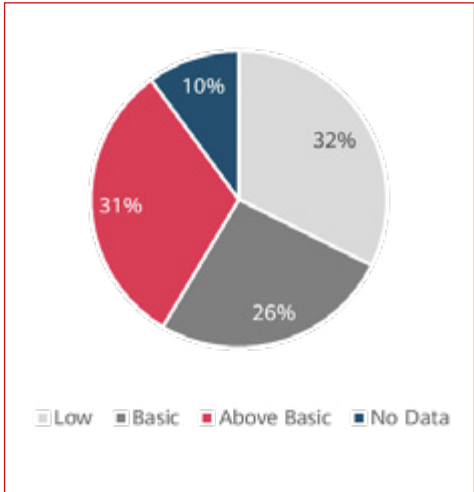
France’s performance has generally followed the EU trends in terms of the evolution of the level of digital skills over time. In particular, France showed an increase in the share of people with basic and above basic digital skills, but its performance in 2020 (57% and 31% respectively) remained below the EU average (58% and 33% respectively). These numbers have remained fairly stable in the country, and only in recent years (since 2018) has the number of people with basic skills started to decrease. The main drivers for the ICT shortage in France are the intensive growth of the demand and the

lack of graduates in relevant fields. In 2019, only 3.0% of French students in tertiary education were enrolled in ICT-related academic programs, well below 4.9%, the EU-27 average⁶³. This figure has been growing steadily in France since 2013, with a peak in 2018 (4.0%) and a sharp decrease in 2019, a phenomenon that is not observed in general European trends. The growth rate of this positive trend, nevertheless, is believed to be widely insufficient to accommodate the demand for ICT specialists. France is only slightly below average with respect to ICT graduates: in 2018 it was 3.5% of the overall number of tertiary education graduates, against an EU-27 average of 3.8%⁶⁴.

The percentage of enterprises providing ICT training for their personnel was 11% in 2020, below the EU-27 average (15%). The French scenario mirrors the broader trends in Europe: in 2020 ICT training services provided by firms dropped, surely as a result of the Covid pandemic. The percentage of enterprises providing ICT training to their IT or ICT specialists was 9% in

2020, in line with the EU-27 average (10%) and remained fairly stable throughout the last decade. France is behind Europe in some key indicators: the percentage of enterprises that employ ICT specialists (18%) is lower in France when compared to the European average (19%). This slight inferiority is reflected also in small and medium enterprises, while the relationship is reversed for large firms, where France is ahead of Europe by one percentage

Figure 31 - Percentage of French population with low, basic, or above basic digital skills



Source: Authors’ elaboration of Eurostat ISOC_SK_SDKL_I data.

point. ICT specialists are one of the main shortage occupations in France. In the last decade, the ICT sector had an annual job growth double the national average, given the increasing use of ICT, notably in small and medium enterprises. Some 68% of companies in France indicate difficulties finding candidates that fit all their requirements.

The following Table 7 illustrates the incidence of the four main causes of difficulties in recruiting: The gender gap in digital proficiency in France is relatively narrow. In 2019, 58% of the male population had at least basic digital skills, against a 54% of the female population: a 2-percentage-point gap, which is below the EU-27 average of 4 percentage points (58% and 54% respectively for men and women). In line with European trends, the percentage of male and female individuals with only basic skills is the same (26% in France, 25% in EU-27) and the variations occur only in the percentages of individuals with above basic digital skills.

Table 7 - Percentage of French enterprises reporting the following causes of ICT specialists shortage

Causes of difficulties in ICT recruiting	French enterprises by size		
	Small	Medium	Large
Lack of applications	3%	10%	31%
Lack of relevant ICT qualifications	2%	7%	19%
Lack of relevant work experience	2%	5%	15%
Excessive salary expectations	2%	8%	23%

Source: Authors’ elaboration of Eurostat data.

In France, the gender gap in digital skills emerges more clearly in other areas: in 2019 female ICT specialists made up some 1.4% of the total female workforce (matching the European average); in the same year, only 16.5% of students enrolling in ICT-related academic programs were women (EU-27 average: 22.4%). Finally, in terms of connectivity, France has improved its performance: fixed very high-capacity network (VHCN) coverage registered a significant increase of 9 percentage points to reach 53% in 2021, and fast broadband networks (NGA) coverage, now at 69%, is up 8 percentage points compared with 2020. Both values are still below the EU average, which is respectively 59% and 87%, and rural coverage remains low. For digital public services, France currently ranks 13th in the EU.



Policy response

In September 2018, the French State Secretary for Digital, part of the French National Agency for the Cohesion of Territories (ANCT) launched the “National Plan for Digital Inclusion” as a strategic action.

This plan aims to support the digital transformation of businesses as well as the development of a safe and human-centric digital society in France. Objectives and priorities relate to (1) the provision of support and training to 1.5 million people in topics relevant to digital technology and 21st century competences and (2) combatting the digital divide. Another strong focus of the plan is achieving digital inclusion for at least one-third of the French population over the next 10 years. In order to reduce the skills gap in AI, data science and robotics, in March 2018, the President of the French Republic Emmanuel Macron presented his vision and a 5-year national AI strategy. This strategy is called “AI for humanity” and its main objectives are to improve the AI education and training ecosystem to develop; retain and attract world-class AI talent; to establish an open data policy for the implementation of AI applications and pooling assets together; to develop an ethical framework for transparent and fair use of AI applications. To this end, the French Government will dedicate €1.5 billion to the development of AI by the end of 2022, including €700 million for research.

In response to the COVID-19 pandemic, the European Commission endorsed the French Recovery and Resilience Plan on 23 June 2021 focusing on three main priorities: green and digital transition, competitiveness and social and territorial cohesion. It aims to support research and innovation, increase the deployment of key technologies, accelerate the digitalisation of the public and private sector (and especially SMEs), and upskill the

labour force (and people in general) with digital competences. The plan will invest €39.4 billion in reforms to support the twin digital and green transition. Out of this budget, 21.32% (€8.4 billion) will be dedicated to digital objectives, including digital skills. It also includes significant investments to support education and employment, including specific interventions for digital skills development and lifelong learning at all levels of society and the labour force.

Germany

Key statistics

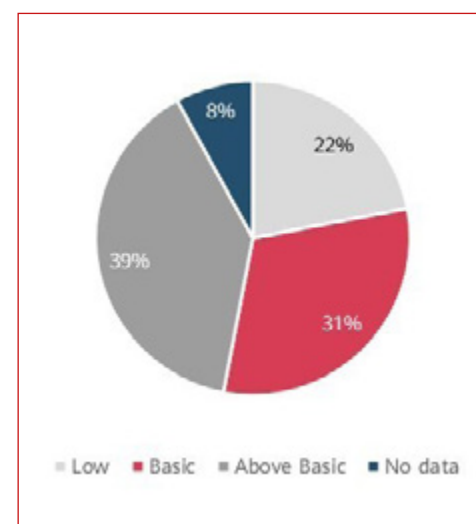
The German situation has been consistently above the average of the Union in the last years. Among the German population, 70% possess at least basic digital skills compared to the EU average of 58%. The general public in Germany is decisively more skilled than in most European countries.

A factor that certainly played a role in this positive outcome is the share of ICT graduates in the country: 4.5% in 2019, which is positive when compared with EU-28 (3.9%) but mixed for German standards (just the year before, it was 4.9%). Certainly, a large enough enrolment in ICT courses offers extra opportunities for digital education and learning.

These encouraging statistics should not mislead us into thinking that the skill gap in Germany is negligible: 10% of all employers reported difficulty in finding adequately skilled ICT personnel, more than the average of the EU-27 (9%). In October 2021, nearly 460,900 vacancies in STEM professions persisted despite over 186,900 unemployed workers seeking work in a STEM field. Adjusting for qualifications mismatches, this is an increase of over 150% since October 2020.

In the field of internal training, Germany is aligned with European trends: the percentage of German employers that provided training to develop/upgrade the ICT skills of their personnel dropped sharply in 2020 to 24% from 32% in 2019. Previously, this figure fluctuated between 28-31% from 2014 to 2018. During the same time period, the EU-27's average ranged from

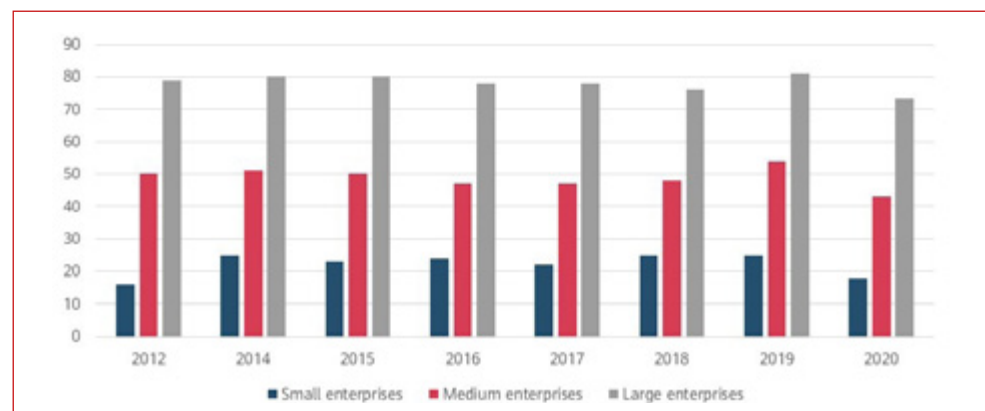
Figure 32 - Percentage of German population with low, basic, or above basic digital skills



Source: Authors' elaboration of Eurostat ISOC_SK_SDKL_I data.

20-23% from 2014 to 2018. Large enterprises in Germany (not including the financial sector) were the most likely to provide ICT skills training to their personnel (73%). Among medium enterprises, 54% provided ICT skills training to their personnel. Only 18% of small enterprises provided such training to their personnel.

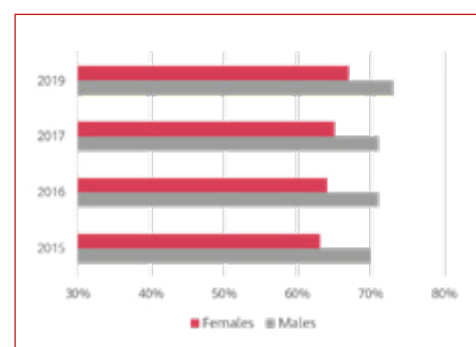
Figure 33 - Percentage of German enterprises that provided ICT training to their personnel, by size



Source: Authors' elaboration of Eurostat ISOC_SKE_ITTN2 data.

Compared to its performance in other indicators, Germany falls notably behind in the gender gap of digital skills: In Germany, a gap of six percentage points persists between males and females with basic or above basic digital skills (73% of males and 67% of females).

Figure 34 - Percentage of German population with at least basic digital skills, by gender



Source: Authors' elaboration of Eurostat ISOC_SK_SDKL_I data.

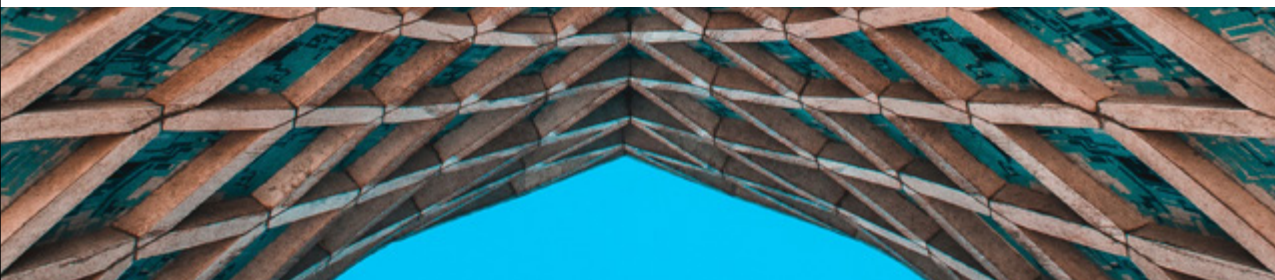
In the EU, the gap is four percentage points (60% of males and 56% of females). Despite the average level of digital skill proficiency in Germany being higher, the gender gap is wider. Moreover, roughly 18% of the German ICT specialists are women (EU-27: 19%). Concerning digital public services, Germany obtained mixed results. Some 89% of German households had access to broadband coverage. Despite this percentage being almost equal to the EU average (90%), Germany used to have an outstanding result in this indicator, considering that in 2015, when the EU average was 78%, Germany registered an impressive 88%. After seven years, little or no improvement has taken place. Germany ranked 6th in the

“connectivity” DESI 2021 indicator, which is supposed to capture the quality of digital infrastructures. In the indicator “digital public services”, however, Germany ranked 16th.

Policy responses

Germany's policies address some of the areas of attention and opportunity from Chapter 2. In particular, two projects are aimed at increasing and improving educational opportunities: the Digital School Compact and the Digital Education Initiative. The 2019 Digital Schools Compact amended the German Basic Law to allow the federal government to allocate funding to lower-income Lander to digitalise their schools. The 2019 Digital Schools Compact earmarked over €5 billion towards educational digitalisation, with Lander required to match 10% of the federal contribution for each grant awarded. A complicated application and tendering process has limited states' ability to take advantage of these funds.⁷⁶ Following the Digital Schools Compact, the 2021 Digital Education Initiative (“DEI”) seeks to put Germany at the forefront of digitalisation education. The 2021 DEI projects include the Digital Pact for Schools, investing 6.5 billion to equip teachers and their classrooms with adequate digital technologies; ‘School Cloud,’ to enable remote access to school materials and digital teaching; ‘Vocational Training 4.0,’ to conduct research into the digitalisation of selected occupations and providing digital re-skilling to workers. The mobile application “Stadt | Land | DatenFluss” (“City Country, Data flow”) was launched in tandem with the DEI announcement in 2021, seeking to improve the general public's digital literacy and digital competencies. Another aspect on which German policymakers focuses is the encouragement and support of women: in Munich, the Lander leading Germany's digitalisation transition, steps ahead of its runner-up Berlin⁷⁷, one joint initiative between the two leading cities is the ReDI School of Digital Integration Programme launched in 2017. Originally founded to serve refugees, particularly women, the program has expanded to include offerings for young people and teens. The school offers short-term, intensive programs, workshops, and events focused on IT-related employment skills. The school has so far offered courses to 1,500 people in Munich and involves over 500 volunteers. Finally, German policies have been promoting collaboration within the digital skill ecosystem, to involve in the strive for further progress of all relevant players in the field. This was done through the 2017 Platform Industrie 4.0 (Plattform), which focused on addressing the evolving relationship between the manufacturing sector and digitalisation (previous versions were released in 2013 and 2015). Supported

by the Ministry of Education and Research and the Ministry for Economic Affairs and Energy, the Plattform provides a framework through which over 350 stakeholders, public and private, (policymakers, industry players, SMEs, labour representatives) collaborate to promote the integration of digital technology into business models, value chains, and products delivery.



Italy

Key statistics

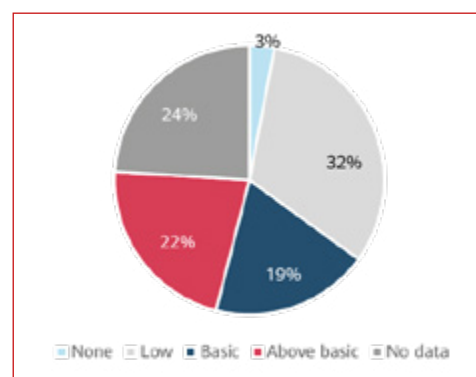
The Italian situation, as we anticipated, is far below the other case studies we considered and Europe in general. The percentage of individuals with at least basic digital skills in Italy in 2020 was 42%, 14 percentage points

behind the EU-28 average (56%). Only 22% of the Italian population scored at above basic level of overall digital skills, against 31% in the EU.

Figure 35 shows the general composition of the Italian population in terms of digital skills. The percentage of universities offering ICT courses offered in Italy is notably limited, as is the number of students enrolling in 2019 the graduates in ICT disciplines were roughly 1.3% of the total. The European average in the same year was 3.9%.⁷⁸ Alongside the constantly increasing demand by firms for these occupational profiles, the insufficient number of graduates is the main driver of the shortage of ICT specialists⁷⁹.

In 2020, ICT specialists were one of the most demanded positions in Italy, and yet only 13% of Italian enterprises employed an ICT specialist⁸⁰. 38% of Italian companies reported hard-to-

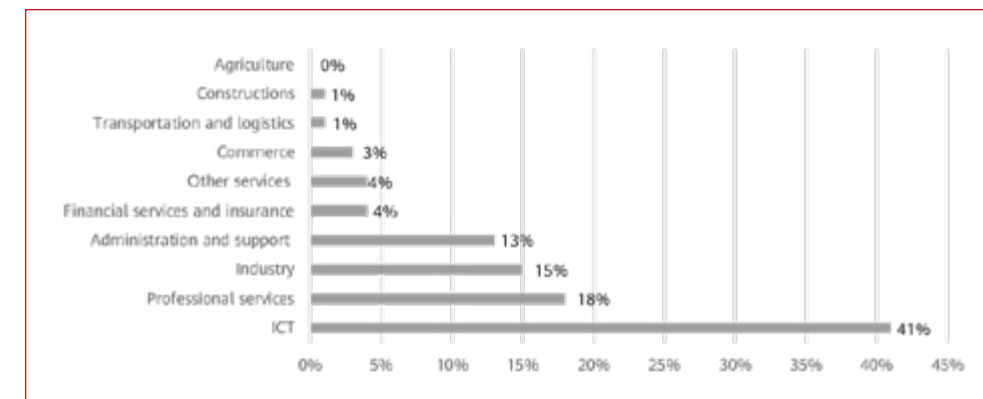
Figure 35 - Percentage of Italian population with low, basic, or above basic digital skills



Source: Authors' elaboration of Eurostat ISOC_SK_DSKL_I data.

fill vacancies for software and application developers and analysts. In the same fashion, in 2015 43% of enterprises defined their vacancies for electrotechnology engineers as hard to fill⁸¹.

Figure 36 – Percentage of job listings by Italian firms by sector

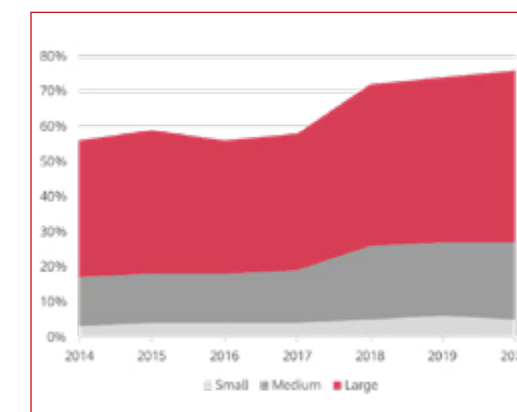


Source: Authors' elaboration of data from Osservatorio delle competenze digitali report 2019.

In Figure 36, the prominence of the need for ICT specialists is shown as a percentage of all job listings issued by Italian enterprises concerned the ICT sector in 2018⁸². To address this issue, the percentage of enterprises providing or paying for digital training for their personnel has been growing steadily in Italy, from 11% in 2012 to 19% in 2019.

As in most countries in Europe, the positive trend in Italy took a sharp dive in 2020 to 15%. As in most other countries, the size of the enterprise is a good predictor of whether it provides digital training (see Figure 37). We considered the gender gap as one of the main variables involved in determining the digital skills gap. In Italy, the gap is only slightly wider than the European average: in 2019, 45% of Italian male individuals had basic or above basic digital skills, while the percentage of women for the same indicator was 38% (EU-27 averages were 58% and 54%, respectively). The percentage of female

Figure 37 – Percentage of enterprises providing training for their personnel, by size



Source: Authors' elaboration of Eurostat ISCO_SKE_ITTN2 data.

ICT specialists was 16% in 2020 (EU-27: 19%).

Finally, the current Italian infrastructure for digital proliferation is severely lacking. In some indicators, Italy scores close to the rest of the Union: in 2020, for instance, some 87% of Italian households have access to broadband coverage, only three percentage points below the EU average. However, Italy's rank in relevant DESI indicators, like connectivity and digital public services, is dissatisfying in 2020 Italy was respectively 18th and 25th out of 28.

Policy responses

Public initiatives tackling the skills gap are fairly recent (from 2019 on). This can account both for the poor performances in years prior to and immediately after 2019 and for the improvement Italy obtained in the DESI 2021 report. In 2020, the Ministry for Technological Innovation and Digital Transition launched the National Strategy for Digital Skills. It focuses on four objectives: (1) digital education in schools, (2) digital upskilling of workforce, (3) ICT specialist education and (4) digital proficiency of citizens in general. The project is tailored to the first area of attention and opportunity highlighted in Chapter 3, providing new education and learning opportunities to all the most relevant demographics. The project includes 24 lines of action just for the fourth goal, for instance, the creation of a digital training platform dedicated to digital training, cooperation with schools to provide formal education for adults, strengthening of local adult training providers, national seminars, and digital onboarding via television programmes (to appeal to digitally illiterate persons)⁸³.

The Nation Strategy for Digital Skills is part of a broader project named Digital Republic, led by a government-appointed Technical Committee. The nature of this initiative fits the fifth area of attention since it is a partnership between all relevant actors in the training ecosystem: between public agencies (representative of the regions, the municipalities, other ministries, universities, etc.) and private firms (e.g., Confindustria, the General Confederation of Italian Industry). Official data states that 2.7 million students, 70,000 teachers, more than 900,000 citizens and more than 250,000 workers received digital education thanks to the project⁸⁴. Given the variety and the sheer number of smaller initiatives falling under its aegis, Digital Republic includes projects aimed at the other areas of attention: some are aimed at women (encouragement and support of women), others at companies who wish to train their employees (need for training/upskilling/reskilling).

Furthermore, in 2022 and the following years, the reforms and investments planned in the National Resilience and Recovery Plan (NRRP) will be implemented, addressing the last area of interest (institutional preparedness

and digital infrastructures). One of the six main missions (M1) of the Plan is dedicated to digitisation and innovation. Sub-mission M1.C1 of the NRRP deals with digital public services: €6.14 billion will be spent on the digitisation of the public administration (cloud migration, support to digitisation of local entities, upskilling of civil servants), 2 of which only for promoting digital citizenship and services⁸⁵.



Notes

- 72. Further details are provided by Eurostat and on Carretero Gomez, S., Vuorikari, R. and Punie, Y. (2017), DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use, EUR 28558 EN, Publications Office of the European Union.
- 73. Data on the outsourcing of ICT functions per focus sector is available only for 2015, 2016 and 2018. We have taken the average of those years.
- 74. Eurostat ISOC_SKE_ITTN2 data.
- 75. Eurostat ISOC_SK_HOW_I data.
- 76. OECD (2021), Getting Skills Right Continuing Education and Training in Germany, OECD Publishing.
- 77. Börsch, Alexander (2019), Tech-Hub-Index: Deutsche Städte Im Vergleich Wirtschaftsdienst.
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- 83. Presidenza Del Consiglio Dei Ministri, Strategia Nazionale per le Competenze Digitali – Decreto ministeriale del 21/7/2020.
- 84. Ministro per l'innovazione tecnologica e la transizione digitale. Repubblica digitale - I Dati, Repubblica Digitale website.
- 85. Piano Nazionale Di Ripresa e Resilienza - Governo: www.governo.it/sites/governo.it/files/PNRR_0.pdf.



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ALL DIGITAL

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ALL DIGITAL is supporting its member organisations in equipping all people with digital skills, with confidence, and with a mindset that allows them to understand how digital transformation can contribute to a greener, more sustainable, inclusive, and cohesive growth of the society, as well as how digital competences can enhance their personal and professional development.

ALL DIGITAL represents digital education stakeholders, such as digital competence centres, adult education centres, community centres, schools, libraries and their networks across Europe where young people and adults can access training and support to improve their digital skills and keep up to date with the latest technology developments.

ALL DIGITAL focuses on supporting all Europeans to enhance their digital skills and employability, to use online services and to be included in today's society, with the ultimate goal of improving their quality of life.

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