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Accompanying the documents

Proposal for a Council Recommendation
on the key enabling factors for successful digital education and training

Proposal for a Council Recommendation
on improving the provision of digital skills in education and training

{COM(2023) 205 final}

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INTRODUCTION

This Staff Working Document accompanies the proposals for a Council Recommendation on the enabling factors for successful digital education and training and a Council Recommendation on improving the provision of digital skills in education and training.

In 2020, the European Commission adopted the **Digital Education Action Plan 2021-2027**[1] setting out a long-term approach and vision for high quality, inclusive and accessible digital education in Europe. The Action Plan is a key enabler of the European Education Area[2] and it contributes to Europe's recovery and resilience strategy in the aftermath of the COVID-19 crisis. It is in line with the Commission's broader priority A Europe fit for the Digital Age[3] and Next Generation EU[4] (with its centrepiece the Recovery and Resilience Facility[5]), which aims to create a greener, more digital and resilient European Union, better fit for the current and forthcoming challenges. Its actions contribute to achieving the goals of the European Skills Agenda[6], the European Social Pillar Action Plan[7] and the 2030 Digital Compass: the European way for the Digital Decade[8].

Calling for greater cooperation at European level to address common challenges and opportunities, the Digital Education Action Plan set out **two strategic priorities** for digital education and skills in Europe:

- Fostering the development of a **high-performing digital education ecosystem**;
- Enhancing **digital skills and competences** for the digital transformation.

Digital education is instrumental for learners to acquire the skills they need to thrive in today's world and for Europe to become a global leader in the digital transformation. With this aim, the Digital Decade sets **ambitious targets and objectives for Europe's digital transformation by 2030**. As shown in Figure 1, they include four key pillars: skills, infrastructure, business and government.

[1] Communication accompanying the Digital Education Action Plan 2021-2027, Resetting education and training for the digital age, COM(2020) 624 final.

[2] European Education Area explained | European Education Area (europa.eu)

[3] A Europe fit for the digital age (europa.eu)

[4] Recovery plan for Europe (europa.eu)

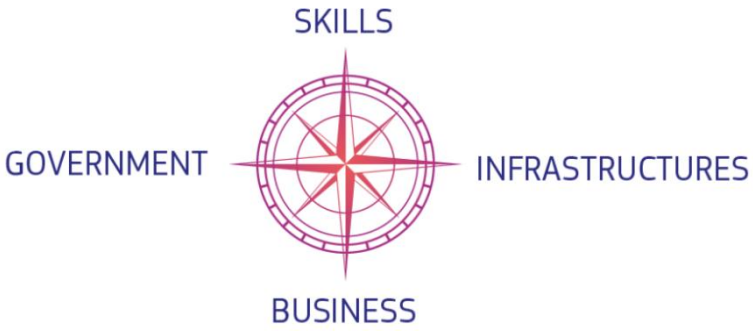
[5] Recovery and Resilience Facility (europa.eu)

[6] European Skills Agenda - Employment, Social Affairs & Inclusion - European Commission (europa.eu)

[7] The European Pillar of Social Rights Action Plan (europa.eu)

[8] Europe's Digital Decade: digital targets for 2030 (europa.eu)

Figure 1: The four pillars of the Digital Decade



Infrastructures and **skills** are particularly important for education and training systems. On one side, the **availability of connectivity** (e.g. Gigabit for everyone) has a strong impact on the ability of education and training institutions to use digital technology in teaching and learning. On the other, **digital skills** are essential to address the needs of Europe's society and economy, as well as to facilitate the efficient and meaningful application of technology in teaching and learning. In particular, the Digital Decade[9] targets aim at ensuring that 80% of adults have at least basic digital skills and that 20 million ICT specialists are in employment in the EU by 2030. Of these, women should represent a significant proportion to reach gender balance in the long-term. These are complemented by a target set in the European Education Area[10] of reducing the share of low-achieving eight-graders in computer and information literacy to less than 15% by 2030.

The achievement of these targets requires efforts at all levels and by all education and training sectors. Considering the work ahead, in the context of the Council Conclusions on digital education in Europe's knowledge societies[11], Member States invited the Commission to launch a strategic reflection process on the digital transformation of education and training systems. In the 2021 State of the Union address, Commission President von der Leyen had stressed that that digital education and skills *need leaders' attention,* and launched a **Structured Dialogue** to support Member States with an integrated, coherent and more ambitious approach. As part of this process, bilateral meetings with 27 Member States took place from April to November 2022, bringing together different Commission services, and representatives of different sectors of government, as well as the private sector, social partners and civil society, in each country.

The Structured Dialogue established a useful platform to discuss with Member States the current state of play regarding digital education and skills, existing and emerging challenges, as well as possible solutions to advance the delivery on Europe's ambitious targets and objectives. As part of the process, Member States nominated their representatives for the High-Level Group of National Coordinators for the Structured Dialogue on Digital Education and

[9] Communication accompanying the 2030 Digital Compass: the European way for the Digital Decade, COM (2021) 118 final.

[10] Council Resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021-2030) 2021/C 66/01.

[11] Council conclusions on digital education in Europe's knowledge societies, 2020/C 415/10.

Skills, reflecting a whole-of-government approach, with the mandate to represent the relevant departments in their countries responsible for different aspects of digital education, training and skills (including education, labour, digital, industry and finance).

In their **Recovery and Resilience Plans** (RRPs), Member States have allocated EUR 130 billion to measures supporting the digital transformation – 26% of the total allocation of plans. Of this amount, EUR 16.5 billion is dedicated to improving connectivity and almost EUR 23 billion to digital education and digital skills development[12]. Implementation of the RRPs is now of utmost importance.

The **two proposals for Council Recommendations,** which are underpinned by the present Staff Working Document, build on the outcomes and lessons learned through the Structured Dialogue[13], and aim to support Member States in the implementation of reforms and investments included in their national Recovery and Resilience Plans.

The **Council Recommendation on the enabling factors for successful digital education and training** addresses the first priority of the Digital Education Action Plan (e.g. fostering the development of a high-performing digital education ecosystem). Its objective is to support Member States in the digital transformation of their education and training systems by addressing key factors such as investments in connectivity, infrastructure, content, and other capabilities as well as related policy reforms which are decisive for ensuring access to high quality and inclusive digital education.

The **Council Recommendation on improving the provision of digital skills in education and training** responds to the second priority of the Digital Education Action Plan (e.g. enhancing digital skills and competences for the digital transformation). It aims to support Member States in addressing common challenges related to digital skills and the ability of their education and training systems to support their provision.

The two initiatives are **separate but complementary**. The Council Recommendation on the enabling factors for successful digital education and training is focused on human capital development, infrastructure and connectivity, and promotes a whole-of-government approach to digital education, as essential pre-conditions for the digital transformation in education and training. The Council Recommendation on improving the provision of digital skills in education and training specifically looks at the educational offer of digital skills at all levels (e.g. basic, advanced and specialist skills) and for all groups of the population (e.g. young people, adults and professionals). It sets out measures, complementary to the ones of the former Council Recommendation, addressing all sectors and levels of education and training and aiming to strengthen digital skills development in a lifelong learning perspective.

Both Council Recommendations address the competences of teachers and training staff, but from a distinct angle. While the Council Recommendation on the enabling factors for successful digital education and training addresses all teachers and training staff and refers to their ability to apply digital pedagogy (e.g. the knowledge and skills needed to use digital

[12] The figures in this paragraph are calculated using Annex VII of the RRF Regulation.

[13] For further details see Annex 3 of this Staff Working Document.

technology in a purposeful way in teaching and learning), the Council Recommendation on the provision of digital skills in education and training specifically looks at the availability and needs of specialised teachers and training staff, namely of those who have the responsibility to teach students digital skills through specialised content and subjects as for instance informatics.

The present Staff Working Document is divided in **two main parts** addressing the two proposals for Council Recommendations.

The document presents **a synthesis and analysis of the evidence** collected from the most recent available literature, studies and reports as well as through stakeholder consultations that have taken place during the preparation of both initiatives. Due to the low frequency of international data collection on digital education and skills, much of the quantitative evidence presented in the document stems from pre-COVID-19 studies. To account for the developments of the last several years, it is complemented by evidence from more recent reports on smaller samples, as well as the rich qualitative evidence collected through the Structured Dialogue. The scarcity of regular new data in this highly dynamic and fast-evolving field highlights the need for a more systematic approach. **Five annexes complement the main document and provide:** further information on the development of the two initiatives (Annex 1); stakeholder feedback and views (Annex 2); a report of the Joint Research Centre providing an in-depth analysis of the outcomes of the Structured Dialogue, of Member States' plans for investments and reforms in digital education and skills through the Recovery and Resilience Facility, and of stakeholder feedback in response to the Call for Evidence of both initiatives (Annex 3); a glossary of key terms (Annex 4); references and main sources (Annex 5). Unless otherwise stated, references to analyses of the Structured Dialogues, the national recovery and resilience plans and submissions to the Calls for Evidence refer to analyses in the report in Annex 3 of this document.

Structured Dialogue with Member States on digital education and skills

The Structured Dialogue was a process of exchange on digital education and skills between the European Commission and the Member States which ran during 2022. The dialogue was conceived and implemented in a transversal whole-of-government approach, involving the different concerned departments of governments in Member States, with the objective of supporting Member States in the digital transformation of their education and training systems in an integrated, coherent and more ambitious approach, by sharing experiences and lessons learned, successes, good practices and challenges.

Interaction with the Member States took place through meetings of the High-Level Group of National Coordinators for the Structured Dialogue on Digital Education and Skills, discussions in relevant Council formations, and individual bilateral meetings with all Member States. These bilateral meetings included representatives of different sectors of government relevant to digital education and skills policies (education, digitalisation, labour, finances), as well as the private sector, social partners and civil society, with the aim of bringing together the different strands of policy and making the most of the synergies between the different policy fields.

The discussions covered all topics of relevance to digital education and skills in a lifelong perspective. A summary of the key findings stemming from the discussions is presented

below[14], grouped according to the themes of the two Council Recommendations. The findings are referenced throughout the Staff Working Document whenever relevant, and a more in-depth analysis is presented in Annex 3.

Findings from the Structured Dialogue concerning enabling factors for digital education and training

Infrastructure, connectivity and equipment are being prioritised across a large majority of Member States. Emerging trends, building on the learnings of the pandemic were that: large-scale investment in devices is taking place; there is ongoing, substantial investment in improving connectivity; and specific measures targeted at disadvantaged learners in formal education settings commonly include the provision of free devices. There are variations within Member States in levels of connectivity/coverage. Two main challenges emerged with respect to infrastructure, connectivity and equipment: a majority of Member States do not yet have systems to track the use of digital equipment in education settings; and a few MS expressed concerns about the maintenance of connectivity, equipment and devices (in terms of lack of human resources to provide technical support and maintenance to schools, refurbishment/recycling, and in obtaining Finance Ministry support for investment in connectivity for schools).

Member States are making significant efforts to support their digital education ecosystems through a range of digital content, tools and platforms, many building on work that began with the onset of the pandemic. An emerging trend is the development of integrated platforms that provide educators and students with a single entry point. Three key concerns were raised in the SD discussions: challenges for schools and other educational institutions to meet General Data Protection Regulation (GDPR) obligations; complex interoperability and legacy platform system challenges; and matching the pace of technological change with updated teaching and learning content and tools.

Almost all Member States described implementing multiple networking and collaborative initiatives to support an enabling ecosystem for digital education. An emerging trend is a dedicated digital education support role for schools, includes both technical support and maintenance as well as digital pedagogy and strategic planning elements.

Many Member States are in the process of implementing Continuous Professional Development (CPD) on a large scale, building on the learnings from the pandemic, and frequently combining both digital skills training for educators with enhancing their digital pedagogical competences. Some gaps are apparent: while participation in CPD is monitored in a majority of Member States, there was much less focus on its impact. CPD programmes for education leaders were mentioned in some SD discussions but were less widespread than CPD for teachers, and the focus on CPD generally was at the primary and secondary levels rather than Vocational Education and Training and Higher Education. Further, in some Structured Dialogue discussions, it was felt that solutions were needed to address low or varied teacher motivation

[14] The thematic analysis was prepared by the European Commission's Joint Research Centre and is based on presentations prepared by each Member State for the bilateral meetings and the notes of discussions that took place during the meetings. All findings are presented in a synthesised format reflecting common trends, without identifying any Member State individually.

to engage in CPD and to strengthen digital leadership in school management. Where Initial Teacher Education (ITE) was discussed, most indicated that ITE included a mandatory component on digital pedagogies. Challenges in relation to ITE and CPD were discussed in 17 Structured Dialogue meetings, frequently in relation to the broader issue of teacher supply. Some Member States commented on a perceived mismatch between the training offer and the needs of educators. This could be exacerbated by the fact that many Member States do not currently have a fully-developed system to assess or monitor teachers' skills and skills needs (although several Member States reported positively on the European Commission's self-assessment tools for schools and educators, SELFIE and SELFIEforTEACHERS). It was noted that Higher Education Institutions (HEIs), the primary source of ITE courses, are relatively autonomous.

Over half of Member States (14) expressed concerns about the digital divide (in particular in reaching vulnerable groups), recognising it as an issue with multiple causes and manifestations. Member States' authorities expressed a need for more support in effectively designing targeted investments to foster equity and equality in digital education, as well as in monitoring the impact and effectiveness of such efforts.

While all Member States expressed an awareness of the importance of monitoring, evaluating and assessing enabling factors, Member States are at different stages of doing so: monitoring systems are well-developed in only a small number of Member States, while many have a fragmented or ad-hoc approach to monitoring. It was common for Member States to describe challenges in achieving an integrated and systematic approach to monitoring the digital education ecosystem.

A clear emerging trend is the adoption by a large number of Member States of whole-of-government approaches to digital education and digital skills policy development and implementation. However, a majority of Member States found these co-ordination efforts challenging across government departments, across levels of government (e.g. national-regional), and with different stakeholders, particularly at the implementation and monitoring phases. Many Member States have multiple national strategy and policy documents relating to digital education, which could be both a symptom and a cause of challenges in implementing whole-of-government approaches.

Another emerging trend was the recent increase in EdTech activities, and many Member States officials recognised the potential of working with the EdTech industry to further improve or enhance digital educational infrastructure, tools and content. Concern or uncertainty was expressed in some Structured Dialogue meetings in relation to managing regulatory and data privacy aspects of the EdTech industry and/or the influence that EdTech may have on education systems.

Key areas for which advice or support from the EU is needed were: research and gathering of evidence in relation to enabling factors; funding supports for infrastructure and connectivity; and technical and operational advice or support concerning data privacy, interoperability of digital education platforms and updating of (digital) pedagogical content and tools.

Member States also sought more opportunities to exchange best practices with one another in a range of areas including reaching remote and vulnerable groups; engaging educators in CPD; digital content and solutions for digital pedagogies; the use of digital education tools and frameworks such as SELFIE and DigComp; models for the provision of technical support to schools; and sharing of solutions to technical challenges (e.g. interoperability).

The Structured Dialogue discussions included calls for the European Commission to strengthen its co-ordination and regulatory activities in a range areas, including awareness-raising and use of common language/terminology and standards in digital education; further alignment and connections of various initiatives within and across EU institutions; stimulation of partnerships between EdTech and public sector organisations; regulation of the EdTech industry; regulations and support concerning interoperability; monitoring Higher Education digitalisation strategies; data privacy policy consolidation; and alignment in the use of the European Digital Competence framework (DigComp). Member States' representatives also sought ways to improve networking between EU countries on enabling factors themes and priorities.

Findings from the Structured Dialogue concerning digital skills

Digital skills initiatives outside of formal education settings was the most frequently referenced topic in the Structured Dialogue discussions. The focus was on delivering training to the desired group(s) rather than on monitoring the outcomes and impacts of these initiatives. In a majority of Member States, digital skills training offerings were perceived to be insufficient to meet current needs, both for general training and for ICT specialists, with some tension between investing in advanced digital skills and digital skills for all. A majority of Member States expressed concerns about the shortage of ICT specialists. Some Member States reported that engaging adults in digital skills training was challenging. Upskilling and reskilling of SME employees was seen to be more of a challenge in Member States where large percentages of the workforce were employed in SMEs.

Recent and current curricular reforms were referenced by about two-thirds of Member States. There is considerable variation across Member States in the positioning of digital skills in national curricula and, overall, a low emphasis on the assessment of learners' digital skills. There is an emerging trend to teach digital competence both transversally and as a separate subject. There is also an emergence of teaching and learning informatics at upper primary and/or lower secondary levels, commonly as a separate, core subject.

In Higher Education, there is more of a focus on the development of programmes to teach specialist and advanced digital skills than on general digital skills, although about half of Member States reported implementing combined skills programmes (generalist-specialist). A strong emerging theme in the Vocational Education and Training (VET) sector is a focus on aligning and reforming VET curricula to labour market demand, with digital skills playing a major role in these efforts. To tackle the ICT skills shortage, Member States are implementing a variety of initiatives in Higher Education and VET, including more course places, and/or shorter or more flexible courses, many of these supported by microcredentials development. Many Member States sought solutions to the labour market 'pull' on ICT students and identified competition between these courses and those for ICT teachers. Some Member States are

implementing ICT profession visa schemes and/or schemes to attract students from overseas as part of their efforts to tackle ICT specialist shortages.

Several Member States reported difficulties in achieving sustained engagement of teachers and educators in CPD (which is exacerbated by teacher shortages in several MS); implementing and assessing learning targets in a transversal approach; and various challenges associated with curricular reform.

A clear trend in the provision of CPD and ITE in digital skills is the widespread use of online training at a large scale, building on the experiences of the pandemic. The general trend in ITE is towards the inclusion of digital skills as a core part of preparatory courses. The link between the digital skills acquired during ITE and how to sustain this with CPD was absent from Structured Dialogue discussions, and the discussions did not provide much information on the expected impacts of teacher professional development. In Member States where CPD was optional, there were more challenges in engaging the teaching profession, and the training offer tended to be more fragmented.

One of the two dominant themes in equity and inclusion aspects of digital skills provision was women in ICT. The widespread concerns about the insufficient number of ICT graduates was viewed in some of the Structured Dialogue meetings as an opportunity to further prioritise bringing more women into the profession. In this respect, various initiatives were described, but these tended not to be accompanied by information on their impact, and systematic and comprehensive programmes were not widespread. The second theme was digital inclusion, which covered a range of targeted skilling, reskilling and upskilling initiatives. However, it was not commonplace for Member States to refer specifically to individuals with disabilities or special educational needs. A key challenge in equitable provision of digital skills raised during the Structured Dialogue discussions is the level of human resources required to engage meaningfully at local levels with the target communities.

Monitoring and evaluation of digital skills provision was, consistently with enabling factors, viewed as generally challenging. Several trends in this area emerged from the Structured Dialogue discussions: skills accreditation in VET; developing the use of microcredentials in Higher Education and VET; and interest in digital skills certification. Challenges in this area, in addition to those already identified under enabling factors, are related to scaling up successful initiatives; complexity in developing microcredentials and digital skills certifications; measurement and monitoring of teachers' digital skills; accurate digital skills forecasting; and general complexity associated with impact assessment.

Research and data in relation to digital skills provision were concentrated in the employment sector, where a range of data sources and methodologies were being implemented for forecasting. The key challenge in this area was the timely availability of appropriate data for digital skills forecasting. Regarding innovation, many Member States referenced digital innovation hubs, and several are implementing initiatives to promote AI skills or other emerging and advanced technologies, often through the creation of new partnerships (for example across education institutions and between education and industry sectors).

Member States mentioned that they would welcome additional EU support on the following topics: A majority sought further opportunities to exchange learning and good practices in a range of areas, including engaging with hard-to-reach groups; increasing the share of women in ICT; developing data-driven policies; responding to rapidly evolving skills needs; and guidance on the development of public-private partnerships.

Member States also sought further opportunities for exchange with the European Commission and/or efforts on the part of the Commission to support the co-ordination of activities of Member States in a range of areas. These included the co-ordination of efforts to address digital skills gaps; support for multi-country projects on digital skills provision; evaluation of digitalisation and digital skills provision initiatives; clarity in the relationships between the various EU-level digital skills bodies, initiatives, and funding instruments; technical and operational support for the adoption and monitoring of digital skills microcredentials; support for awareness-raising on digital skills, in particular among employer groups; support for the implementation of impact assessment; and strategies to tackle the gender gap in ICT.

To support their efforts, Member States also requested support at the EU level for the development of (objective, psychometrically sound) digital assessment tools for general and specific populations; tools for the monitoring and evaluation of digital skills provision, and also provided suggestions for further development of digital skills frameworks. Member States called for further research and analysis in two areas, specifically: supply and demand forecasting of digital skills, and digital skills provision mapping across formal and non-formal education and training systems.

PART I: ENABLING FACTORS FOR DIGITAL EDUCATION AND TRAINING

1. Enabling factors: an overview of terms and origins

Over the past decades, there have been many initiatives and large investments aimed at increasing the use of digital technologies for teaching and learning and reducing the administrative burden for educators. Despite overall progress and various examples of innovation, Europe has not yet seen a systematic digital transformation in education and training. This has become starkly evident during the COVID-19 crisis, when EU countries had to rely in many cases on ad-hoc solutions to ensure the continuity of education and training. These included the use of commercial videoconferencing platforms for delivering classes, free distribution of digital devices to learners from disadvantaged backgrounds, setting up informal online digital training courses for teachers, etc.[15].

It has long been recognised that the digital transformation has the potential to support education and training not only by making it more resilient in times of crisis but also by enhancing its overall accessibility, quality and inclusiveness. This is reflected in the first strategic priority of the Digital Education Action Plan 2021-2027[16], which aims at fostering the development of a high-performing digital education ecosystem. The reference to **ecosystem** clearly shows the need for integration of several diverse but inter-related elements which are at the core of successful digital education, such as infrastructure, teachers' professional development, governance arrangements and targeted policies. These building blocks, which are referred as "enabling factors" are essential for ensuring high-quality, accessible and inclusive digital education and training. They stress the need for purposeful and meaningful use of digital technologies with a view to create more and better opportunities for everyone in the digital age.

The first list of enabling factors was provided in the Digital Education Action Plan 2021-2027 and complemented in the **Council Conclusions on digital education** in Europe's knowledge societies[17]. This list included elements such as infrastructure, know-how on digitalisation, dialogue with stakeholders and teachers' skills. The first part of the Staff Working Document (SWD) expands on the initial list, grouping the enabling factors into two categories: capacity for digital education and training and digital education and training policy.

More specifically, it starts by outlining the digital education infrastructure and institutional and human capacities which are the prerequisites for the development of a digital education ecosystem. While these elements on their own cannot guarantee a structural transformation of education and training systems, as noted by the Council they are "the basis for the successful implementation of digital education and a prerequisite" for such a transformation. The next section focuses on digital education policy development, implementation, monitoring and evaluation. It emphasises the vital role of effective planning of digital strategies and

[15] Cachia, R., Velicu, A., Chaudron, S., Di Gioia, R. and Vuorikari, R. (2021). Emergency remote schooling during COVID-19, EUR 30866 EN. Luxembourg: Publications Office of the European Union.

[16] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions, Digital Education Action Plan 2021-2027: Resetting education and training for the digital age, COM/2020/624 final.

[17] Council Conclusions on digital education in Europe's knowledge societies, 2020/C 415/10.

frameworks, and discusses what is needed in order to make the best use of existing capacities in a meaningful way.

Each section presents the current state of play of the issues as well as available evidence on successful approaches to addressing them.

2. Capacity for digital education and training in European countries

2.1. Digital education infrastructure

Connectivity and digital equipment

The level of equity in access to digital technology impacts the degree of effectiveness of digital education policies. Evidence from the OECD's Programme for International Student Assessment (PISA) shows that countries whose schools are better equipped with sufficient digital educational material, such as digital equipment and textbooks, tend to perform better on tests of 15-year-olds' ability to use their reading, mathematics and science knowledge and skills[18]. Moreover, integration of digital technologies in educational institutions acts as an impetus for teachers to design innovative teaching that could enhance student learning, while at the same time a high-speed internet connection either via mobile/fixed networks or communication satellites is crucial to the implementation of digital learning activities, facilitation of student-teacher digital interaction and the interoperability of systems[19]. Connectivity can be a contributing factor to better learning outcomes[20] and especially in higher education it can prove beneficial in supporting online learning[21]. By extension, **access to digital equipment and the internet constitute fundamental prerequisites towards the provision of effective and inclusive digital education**[22].

However, these prerequisites have not yet been fully met in education and training systems across the EU. The latest systematic data collection across Europe on this, conducted during the school year 2017-2018, showed that the share of students who attended highly digitally equipped and connected schools varied greatly across countries and education levels, ranging from 35% in primary, 52% in lower-secondary to 72% in upper-secondary schools and being most advanced in the Nordic countries[23]. Experiences from the COVID-19 pandemic show that the situation has not progressed to a sufficient extent since then. Research has shown that the lack of appropriate digital equipment both in schools and households hindered the continuity

[18] OECD (2020). PISA 2018 Results (Volume V): Effective Policies, Successful Schools. In PISA. Paris: OECD Publishing.

[19] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[20] Sanchis-Guarner, R., Montalbán, J., & Weinhardt, F. (2021). Home Broadband and Human Capital Formation. SSRN Electronic Journal.

[21] Skinner, B. (2019). Making the Connection: Broadband Access and Online Course Enrollment at Public Open Admissions Institutions. Research in Higher Education, 60(7): 960-999.

[22] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[23] European Commission, Directorate-General for Communications Networks, Content and Technology (2019). 2nd Survey of Schools: ICT in Education.

of some students' learning during the pandemic[24]. According to the feedback received in the Open Public Consultation (2020)[25] on the Digital Education Action Plan 2021-2027, insufficient infrastructure is one of the two[26] most considerable challenges for digital education in Europe. Almost half (49.5%[27]) of the responding education and training institutions pointed to insufficient connectivity as a major hindrance. The lack of digital devices suitable for distance and online learning was reported by 34.3% of educators and 33.8%[28] of education and training staff, with the rate going up to 58.2%[29] for education and training institutions. These views were confirmed by stakeholders in the consultations organised by the European Commission in 2022 and position papers submitted in response to the Call for Evidence (CfE) on the enabling factors for successful digital education. Moreover, in the Structured Dialogue with Member States, "infrastructure, connectivity and equipment" was one of the two main topics most often referred as a main challenge to digital education and training.

The mere availability of an internet connection does not always mean a quality high-enough to significantly support the learning process. There is a considerable quality gap between a slow and high-speed and reliable connection[30]. Data from the school year 2017-2018 reveal that a high-speed Internet connection (above 100 mbps) was available in schools only for a small number of students (11%, 17% and 18% for ISCED level 1, 2 and 3 respectively), with even less availability for students in rural areas (8% across all ISCED levels)[31]. Details on the internet speed of schools across all ISCED levels and according to different sizes of residential areas can be found in Figure 2. Similarly, the share of students attending schools with a Wireless LAN connection differed across the EU countries (46%, 52% and 67% for ISCED level 1, 2 and 3, respectively)[32].

[24] Cachia, R., Velicu, A., Chaudron, S., Di Gioia, R. and Vuorikari, R. (2021). Emergency remote schooling during COVID-19, EUR 30866 EN. Luxembourg: Publications Office of the European Union.

[25] Open Public Consultation of the Digital Education Action Plan 2021-2027. See Annex 2 for further details.

[26] Respondents to the Open Public Consultation came from 60 different countries, but due to Romania's overrepresentation, the analysis was conducted using two samples, all respondents ("All countries") and all respondents excluding those from Romania ("Without RO"). 42.4% in the sample of 'All countries' and 49.6% 'Without RO' of the respondents ranked insufficient infrastructure and internet at school/campus and outside as the second greatest challenge for digital education in Europe, while social inequalities between learners was ranked first with 45.5% (in the sample of 'All countries' and 53.8% 'Without RO').

[27] 49.5% in the sample 'All countries' and 51.6% in the sample 'Without RO'

[28] 33.8% in the sample 'All countries' and 32.3% in the sample 'Without RO'

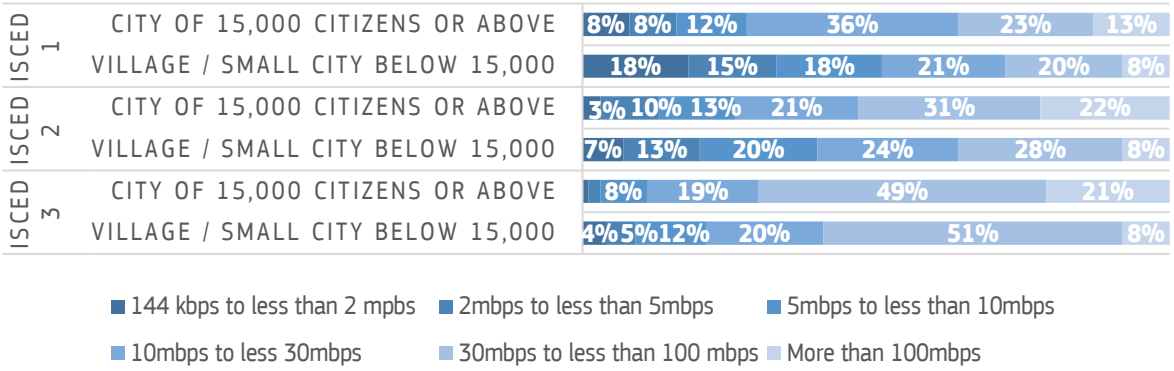
[29] 58.2% in the sample 'All countries' and 56.3% in the sample 'Without RO'

[30] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[31] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

[32] Ibid.

Figure 2: Internet speed according to location of schools (All ISCED levels, in % of students, EU level, 2017-18)



Source: 2nd Survey of Schools: ICT in Education[33]

When it comes to higher education, for most EU Higher Education Institutions (HEIs), National Research and Education Networks (NRENs) are the sole providers of high-capacity internet connection[34], while also supporting them with other services, such as cloud storage and Virtual Learning Environments (VLEs).

With respect to access to digital devices at school level, it is estimated that in 2018 there was an average number of 18 students per computer at ISCED level 1, and 7 and 8 students per computer at ISCED levels 2 and 3 respectively[35]. The availability of school computers with internet connection for teachers varies across countries[36]. During the COVID-19 pandemic, a survey of teachers run on the School Education Gateway showed that the biggest challenge in switching to online or distance learning was the access to technology (computers, software, stable internet connection, etc.), not only by pupils (mentioned by 49.2% of respondents), but also by teachers (34.3% of respondents)[37]. As a consequence, approximately 50% of high-income and upper-middle income countries provided ICT tools and free Internet connectivity to teachers during the crisis[38].

In addition, there is still a significant share of European students who attend schools with digital equipment that is not highly operational. While available data varies largely across countries, the variability in the quality of digital equipment is a common challenge. More

[33] Ibid.

[34] Géant (2020). Compendium of National Research and Education Networks in Europe - 2020. Retrieved from https://about.geant.org/wp-content/uploads/2021/12/Compendium_FINAL2.pdf

[35] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

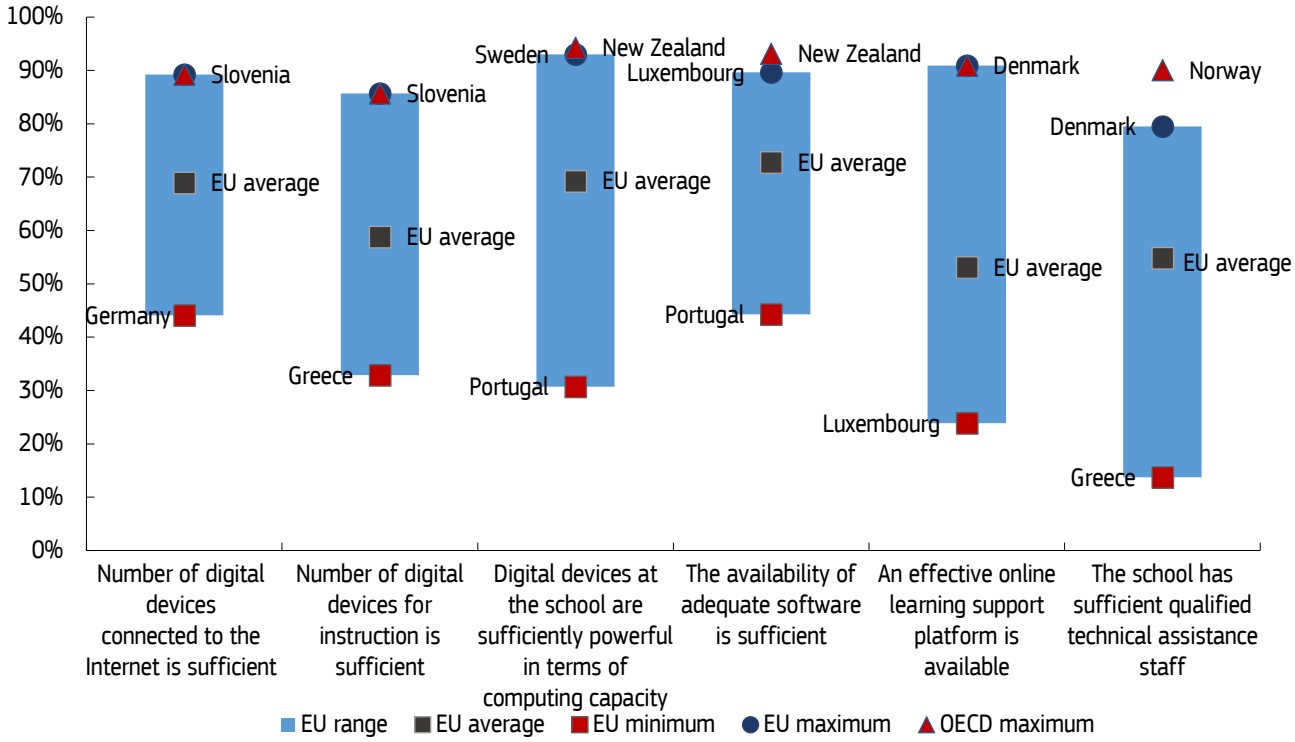
[36] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[37] School Education Gateway (2020). Survey on online and distance learning – Results, Available at https://www.schooleducationgateway.eu/en/pub/viewpoints/surveys/survey-on-online-teaching.htm

[38] UNICEF (2020). What have we learnt? Overview of findings from a survey of ministries of education on national responses to COVID-19. Paris: United Nations Educational, Scientific and Cultural Organization.

specifically, in 2018, only 61% of ISCED level 1 students, 65% of ISCED level 2 and 73% of ISCED level 3 attended schools where more than 90% of their digital equipment was operational[39]. Additionally, PISA 2018 results on the level of adequacy of digital technologies at the schools of 15-year-old students as perceived by their principals[40] (see Figure 3) show wide variations across EU countries in relation to ensuring access to properly equipped digital devices both in terms of hardware and software. Top OECD performers are also included in the figure for purposes of comparison.

Figure 3: Adequacy of digital technologies and availability of qualified technical assistance staff in schools



Source: OECD analysis based on PISA 2018[41]

Raising the availability of digital infrastructure has been at the forefront of most digital strategies in OECD countries, including EU Member States[42]. For many countries in Europe investments in infrastructure constitute a specific objective of their digital education strategy[43].

[39] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

[40] OECD (2020). PISA 2018 Results (Volume V): Effective Policies, Successful Schools. In PISA. Paris: OECD Publishing.

[41] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[42] OECD (2020). Digital strategies in education - Exploring education policies on digital technologies.

[43] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

The Structured Dialogue and the national recovery and resilience plans show[44] that this continues to be the case: for the period until 2026 unprecedented investments have been planned by Member States with the support of EU and national funds; around a total of EUR 16.5 billion[45] is dedicated for investments in providing and enhancing their overall connectivity[46] through the national plans under the Recovery and Resilience Facility (RRF)[47] . Many Member States also plan large-scale investment in devices for pupils.

However, the extent to which countries prioritise their most recent investments in digital education infrastructure depends on their starting point[48]. The Structured Dialogue showed that investments in infrastructure, connectivity and equipment tended to be more widespread among Member States with less well-developed digital education ecosystems. A few Member States have already solved the connectivity issue, while for others, with pronounced geographic, economic and demographic discrepancies, it remains a significant challenge. Looking at the persisting needs in digital infrastructure, stakeholders' contributions point to the need for further investments in this area.

A special focus on underprivileged communities (those without or with slow connectivity) was mentioned as a priority by most Member States in the Structured Dialogue. Other actions that have already been implemented involve providing education and training institutions with targeted funding to improve their connectivity levels as well as supporting the connectivity of schools located in remote areas where commercial investment is less likely to be provided[49]. Some countries have exploited the already existing infrastructure capacity in higher education to help improve the connectivity of other educational sectors. For example, in cases where National Research and Education Networks are the main connectivity providers for HEIs, schools and vocational education and training (VET) institutions tend to also benefit from the already installed capacity to cover their needs[50].

Investments in bridging digital equipment gaps are also set to continue in most Member States under the national recovery and resilience plans, but the specificities of how this is achieved vary. During the Structured Dialogue a few Member States indicated concrete student-device ratio targets they would like to achieve, while a small number of EU countries appear to have already met their targets in this regard. A general trend is the provision of one device per student from upper primary level onwards and one device for every four or five students among younger grade levels. While some countries prefer to provide or subsidise a portable digital device for each student, another common practice is leveraging students' own

[44] Thematic analyses of national recovery and resilience plans on digital skills and education and adult learning and skills: Recovery and Resilience Scoreboard (europa.eu)

[45] The amount is calculated using Annex VII of the RRF Regulation.

[46] European Commission (2022). Digital Economy and Society Index (DESI) 2022 - Digital Infrastructure.

[47] Recovery and Resilience Facility

[48] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[49] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[50] Ibid.

personal digital devices through the Bring Your Own Device (BYOD) strategy[51]. However, concerns related to the quality of students' own devices give rise to issues of equity, privacy and security. Additionally, the effectiveness of this strategy may be limited due to interoperability issues that may arise by the use of a variety of digital technologies in an institution[52]. There are also cases where institutions have used a combination of the two approaches, allowing the use of school or district devices together with the BYOD strategy[53]. Besides the provision of digital devices to students, catering for teachers' access to digital equipment is also essential[54], with many Member States referring during the Structured Dialogue to investments in devices for teachers.

Capital investments (Capex) in digital technologies are however not sufficient, as they must be accompanied by continuous operational expenditure (Opex) for maintenance and upgrading[55]. A few Member States express concerns about the maintenance of connectivity, equipment and devices (in terms of lack of human resources to provide technical support and maintenance to schools, refurbishment/recycling, and in obtaining Finance Ministry support for investment in connectivity for schools), with some of them highlighting the need to incorporate device and equipment refurbishment and recycling in digital education infrastructure planning. The introduction of new software or equipment demanding higher connectivity or device capacity often requires additional investments for upgrading the existing infrastructure[56]. Anticipation of maintenance, upgrading and other investment needs could prove beneficial, allowing solutions to take place before future shortcomings emerge. A cost-benefit analysis would also set the ground for more successful investments and distribution of digital equipment to educational institutions[57]. Stakeholders consider that such costs are not always sufficiently well considered in EU funding programmes in support of digital education infrastructure.

Against this backdrop, representatives of both the private and the formal education sector in the targeted stakeholder consultations (2022) emphasised the importance of the continuity of investments in digital education. This is confirmed by academic literature, which stresses that a long-term perspective should permeate any digital infrastructure related programme, and that the free provision of connectivity and equipment only for a restricted period of time, as was the case in a number of countries during the COVID-19 pandemic, can prove problematic in the sense of requiring families to pay for this service after the emergency period is over[58].

[51] Ibid.

[52] Ibid.

[53] Ibid.

[54] Ibid.

[55] Ibid.

[56] Ibid.

[57] Ibid.

[58] Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency. Learning, Media and Technology, 45(2): 107–114.

The establishment of monitoring mechanisms is also crucial. In the Structured Dialogue, several Member States pointed to difficulties in gathering systematic data on devices and equipment available in schools, thus making planning of future impactful investments more difficult. Maintaining a database with the available digital technologies would enable better understanding of digital divides and better-informed policy development to address them[59]. Additionally, as the Structured Dialogue showed, while some Member States have (or are in the process of developing) systems in place to track infrastructural investments in educational institutions, several noted a lack of a national or regional system to track the use of equipment.

As regards higher education institutions, the Commission Expert Group on quality investment in education and training stressed in its final report that recent investments on innovative digital infrastructure that took place in response to the pandemic should be regularly monitored and evaluated in terms of their impact and effectiveness on educational outcomes[60].

Digital education content, platforms and tools

Respondents to the public consultation (2020) rated *digital resources and materials* and *digital platforms and tools* as the third and fourth most essential elements in the provision of digital education. In the school year 2017–2018 only about half of lower-secondary school students in Europe had access to a Virtual Learning Environment (VLE) at school (54%), with the figure standing at 32% for primary and 65% for upper-secondary students[61]. A few years later, although it can be assumed that VLEs have become more widespread, educators who responded to the 2020 public consultation still found the lack of easy-to-use digital platforms to be a problematic aspect, hindering teaching and learning during the COVID-19 pandemic. This is not surprising given that during the pandemic most countries had to rely at least to a certain extent on ad hoc solutions, such as the use of commercial videoconferencing platforms for delivering classes. Respondents (of the various stakeholder groups) reported that although available digital environments for online collaboration were satisfactory, they still presented large limitations, as they were not tailored to the educational needs[62]. With regard to higher education, several Member States raised concerns during the Structured Dialogue that HEIs are not yet integrating digital content and tools sufficiently to fully exploit their potential. It is not fully clear how representative this is, given that HEIs enjoy greater autonomy than lower levels of education, and were thus less frequently examined in the Structured Dialogue discussions by central authorities.

[59] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[60] European Commission (2022). Investing in our future: quality investment in education and training, Luxembourg: Publications Office of the European Union.

[61] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

[62] Also see: Cachia, R., Velicu, A., Chaudron, S., Di Gioia, R. and Vuorikari, R. (2021). Emergency remote schooling during COVID-19, EUR 30866 EN. Luxembourg: Publications Office of the European Union.

Educational systems in Europe have developed policies towards the improvement of availability and development of digital learning resources[63]. Recurring examples of such efforts from the Structured Dialogue include:

- development of new digital teaching and learning content and tools, and/or digitalisation of teaching and learning materials;
- open education resources as well as platforms that give access to digital educational content, remote/blended teaching and learning platforms, and platforms that facilitate schools' day-to-day administrative and communication activities;
- investments fostering interoperability of systems;
- teaching and learning content/tools for emerging technologies such as artificial intelligence, the Internet of Things, and big data analytics.

Although digital education content is widely available, the lack of mechanisms to guarantee its quality and appropriateness is a reason for educators' hesitance to use it. Digital content that is "relevant and of high quality" was identified by respondents to the public consultation (2020) as the third most important aspect[64] "related to the usefulness of online resources and content", while it was ranked first by digital technology providers. However, the available content is often not in line with teachers' needs. EdTech providers are not always aligned with what could be meaningful and beneficial to teachers and students in practice[65]. Digital education content that has the consideration of end-users at the core of its development and is tailored to specific learning needs can be more effective in the learning process[66]. The involvement of end-users in the design is thus a critical factor for the development of digital education resources that can potentially be impactful[67].

Lack of contextualisation and language barriers are aspects that could limit the accessibility and use of digital education content by educational institutions. Digital learning resources adapted to local contexts and available in different languages are not common[68]. UNESCO's report on the digital transformation of education[69] underlines that in the development of digital education content the local context and language of the educational settings and their surrounding communities should be taken into account. It also suggests that

[63] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[64] Digital content that is "interactive and user-friendly" ranked first, and content that is responsive to "the need to develop skills further and the needs of the labour market" ranked second.

[65] European Agency for Special Needs and Inclusive Education, Weber, H, Elsner, A. Wolf, D., Rohs, M. & Turner-Cmuchal, M. (2022). Inclusive Digital Education. Odense: European Agency for Special Needs and Inclusive Education.

[66] UNESCO (2020). The digital transformation of education: Connecting Schools, Empowering Learners. Geneva: Broadband Commission for Sustainable Development.

[67] European Agency for Special Needs and Inclusive Education, Weber, H, Elsner, A. Wolf, D., Rohs, M. & Turner-Cmuchal, M. (2022). Inclusive Digital Education. Odense: European Agency for Special Needs and Inclusive Education.

[68] UNESCO (2022). Guidelines for ICT in education policies and masterplans. Paris: UNESCO.

[69] UNESCO (2020). The digital transformation of education: connecting schools, empowering learners. Geneva: Broadband Commission for Sustainable Development.

local EdTech providers should be involved in the identification of high-quality digital education content, enabling them to internalise quality and build on it[70].

Quality assurance needs to take a central place when it comes to policy considerations on digital education content. A number of European educational systems have already focused their efforts on ensuring the quality of digital learning resources, while a few have adopted policies including the development of specific quality standards[71]. The use of "quality labels" is identified by stakeholders as one way to ensure quality in digital learning resources, however this entails the development of "common quality standards"[72].

In parallel, the use of digital learning environments is often accompanied by concerns on privacy and security risks. Such concerns were expressed in stakeholders' submissions to the CfE, as well as by participants of the 2022 targeted consultations. The significance of securing transparency in the products developed by digital technology providers was highlighted by a range of stakeholders. The introduction of the General Data Protection Regulation (GDPR) in the EU has significantly increased the threshold for accountability in the processing of data[73], however its implementation has likely varied across Member States[74]. In this regard, the literature points to the need for governments to take systematic actions with regard to concerns on privacy protection specific to the digital learning environments, e.g. ensuring that content providers are mindful of data privacy and promoting learners' awareness of their rights[75] [76]. Data privacy and security were amongst the issues discussed during the Structured Dialogue and for which Member States ask for support at EU level, echoing also the calls of the CfE submissions.

Interoperability is highlighted as particularly important for effectively operating existing different digital tools and systems. During the pandemic, many countries had either developed dedicated national online platforms[77] or helped to consolidate existing learning management systems and platforms, in an attempt to support the tremendous changeover to online and remote education. This switch highlighted the barriers in exchange of information between the numerous technological solutions in use (such as school information and administration systems, virtual exchange platforms, learning management systems, and learning record store systems), especially in areas like identity management, sharing learning

[70] Ibid.

[71] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[72] Engelhardt, K. (2021). The future of school beyond COVID-19, 2020-21 Brussels: European Schoolnet.

[73] OECD (2020). Protecting children online: An overview of recent developments in legal frameworks and policies, OECD Digital Economy Papers, 295, Paris: OECD Publishing.

[74] Ruohonen, J. and Hjerppe, K. (2022). The GDPR enforcement fines at glance, Information Systems, 106, 101876.

[75] Kardefelt-Winther, D., Day, E., Berman, G., Witting, S.K., and Bose, A., on behalf of UNICEF's cross-divisional task force on child online protection (2020). Encryption, Privacy and Children's Right to Protection from Harm. Innocenti Working Paper 2020-14. Florence: UNICEF Office of Research.

[76] Hillman, V. (2022). Bringing in the technological, ethical, educational and social-structural for a new education data governance, Learning, Media and Technology.

[77] Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency. Learning, Media and Technology, 45(2), 107–114.

records, and course exchange. Such challenges were highlighted by Member States in the Structured Dialogue, and several countries also sought EU-level support in overcoming them; aligning with the calls of stakeholders responding to the CfE.

The Structured Dialogue showed that significant efforts and investments are being made by Member States to achieve interoperable education systems, in order to enhance the usability of relevant services, as well as the accessibility and sustainability of data and content available on these platforms. Interoperability challenges (caused by longstanding factors and dynamics such as the reliance on proprietary and/or outdated siloed systems, lack of uniform data standards, and fragmentation in the marketplace) are now being centrally considered, for instance by national frameworks (like the Référentiel général d'interopérabilité in France[78]) or common open standards. As regards the latter, central authorities can encourage educational institutions to adhere to open standards and include interoperability as a central criterion in the upgrading of their technological systems. For instance, external evaluations of schools and HEIs could include criteria on interoperability and alignment to open standards[79]. Governments can also play a strong role in facilitating knowledge-sharing on the significance of open technologies, as well as to support the development of platforms for institutional exchanges on relevant good practices[80].

Finally, education systems need to be ready to adapt and respond to disruptive technologies, such as generative artificial intelligence and other emerging technologies, which quickly enter learners' environments, with the potential risks this entails. Generative AI systems (e.g. large language models) are information technology systems, either software or hardware based, that display intelligent behaviour by analysing their environment and taking actions - with some degree of autonomy - to achieve specific different purposes. To benefit from the ground-breaking potential and large-scale impact of such emerging digital tools, educational systems need to take into account the implications that their misuse could potentially entail.

Digital divide

Social inequalities between learners were identified as the most significant challenge for digital education in Europe among the respondents of the public consultation (2020)[81]. PISA 2018 results indicate gaps in the availability and adequacy of digital technologies between students from advantaged and disadvantaged schools, with more shortages being reported by principals of disadvantaged schools[82]. Discrepancies across and within European countries during the pandemic in relation to learners' digital competences and accessibility to digital technologies, meant that a large part of the European student population – including learners from remote areas, students with a low socio-economic status, as well as migrant and refugee

[78] Référentiel général d'interopérabilité (RGI)

[79] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[80] Ibid.

[81] 45.5% in the sample of 'All countries' and 53.8% 'Without RO'

[82] OECD (2020). PISA 2018 Results (Volume V): Effective Policies, Successful Schools. In PISA. Paris: OECD Publishing.

learners – was at risk of exclusion from distance learning[83]. This was also indicated by a study[84] based on EU data and conducted in the context of the RESISTIRÉ project[85], which showed that students with a lower socio-economic status were less likely to have access to online learning. A correlation between the level of income and access to the internet and digital devices is illustrated by Eurostat data[86] [87], indicating a lower access to digital tools and the internet by disadvantaged learners in comparison to their peers. At the same time, the pandemic revealed the inadequacy of education systems to cater for the needs of some learners with disabilities, as the digital tools that would allow their access to education were not available to them[88].

Before the COVID-19 pandemic, the 'digital' dimension was not explicitly included in measures promoting inclusive education, while at the same time equity and inclusion often constituted implicit objectives within digital strategies[89]. The equity challenges that were highlighted by the onset of the COVID-19 pandemic brought the digital divide into the foreground, functioning as a trigger for many Member States to develop initiatives specifically targeting the digital inclusion of vulnerable groups of learners, including for example the provision of digital equipment to pupils in need[90]. Most Member States in the Structured Dialogue referenced recent investments in devices for students during the pandemic, providing either free or subsidised devices (occasionally these being accompanied by free or subsidised connectivity). The development of tailored educational programmes and supports designed to promote digital inclusion of priority groups was also mentioned. However, not much is known about the outcomes and impacts of such efforts. Overall, Member States widely expressed their concerns for tackling the digital divide among learners and promoting inclusion in their countries.

Education policymakers show an increasing attention to the provision of digital tools that enhance access to education for students with special educational needs[91]. Stakeholders responding to the CfE placed a strong emphasis on accessibility, raising also concerns about the inclusion of disadvantaged students. Accessible digital technologies in line with the

[83] European Commission (2021). Enhancing Learning Through Digital Tools and Practices: How Digital Technology in Compulsory Education Can Help Promote Inclusion.

[84] Stovell, C., Lionello, L., Rossetti, F., Charafeddine, R., Nugent, S., Still, A.,Tanwar & J., Tzanakou, C. (2022) RESISTIRE D3.2 - Summary report on mapping quantitative indicators – cycle 2. Zenodo.

[85] Resistire

[86] European Commission (2021). Enhancing Learning Through Digital Tools and Practices: How Digital Technology in Compulsory Education Can Help Promote Inclusion.

[87] Di Pietro, G., Biagi, F., Dinis Mota Da Costa, P., Karpinski, Z. and Mazza, J. (2020). The likely impact of COVID-19 on education: Reflections based on the existing literature and recent international datasets, EUR 30275 EN. Luxembourg: Publications Office of the European Union.

[88] European Commission (2021). Enhancing Learning Through Digital Tools and Practices: How Digital Technology in Compulsory Education Can Help Promote Inclusion.

[89] Ibid.

[90] Ibid.

[91] Ibid.

Harmonised European Standards[92] could largely facilitate the learning of students with disabilities, while emerging technologies could provide further opportunities for more personalised learning tailored to the individual needs of students. For example, assistive technologies can facilitate access to education for learners with diverse and/or complex learning needs, while artificial intelligence and robotics can support customised learning and provide immersive learning opportunities[93]. User-adapted digital education resources can further facilitate the learning of vulnerable groups of learners[94].

Inclusive education can also be supported by e-learning, open education and MOOCs that can provide learning opportunities for pupils with limited access to education due to physical, geographical or cultural barriers[95]. Another way to support inclusivity in education is through the use of learning analytics which allow a real-time collection and analysis of data that could be used to improve students' learning[96] by making it more personalised and enhancing learners' engagement[97]. Learning analytics can facilitate the diagnosis of needs as well as the planning of targeted interventions in educational settings, and thus potentially promoting equity in learning[98]. Moreover, the Commission is expanding the scope of the EU-funded Safer Internet Centres[99] to impart digital skills, in particular digital literacy, also to vulnerable groups of children.

While assistive and accessible technologies have the potential to enhance the learning process, there is no systematic data on their availability, making it difficult to have a clear picture of the remaining shortages nor their current impact on the inclusion and learning outcomes of learners with special needs. Moreover, in the Structured Dialogue only a few Member States mentioned investments in assistive technologies, signalling a potential need for further prioritisation and co-ordination in integrating such technologies in education.

2.2. Institutional and human capacity

Institutional strategies, evaluation and support

[92] Harmonised European Standard EN 301 549 V3.2.1 (2021-03) Accessibility requirements for ICT products and services - defined in line with the WAD Implementing Decision Commission Implementing Decision (EU) 2021/1339 of 11 August 2021 amending Implementing Decision (EU) 2018/2048 as regards the harmonised standard for websites and mobile applications, http://data.europa.eu/eli/dec_impl/2021/1339/oj

[93] European Commission (2021). Enhancing Learning Through Digital Tools and Practices: How Digital Technology in Compulsory Education Can Help Promote Inclusion.

[94] Ibid.

[95] Ibid.

[96] European Agency for Special Needs and Inclusive Education, Weber, H, Elsner, A. Wolf, D., Rohs, M. & Turner-Cmuchal, M. (2022). Inclusive Digital Education. Odense: European Agency for Special Needs and Inclusive Education.

[97] Vincent-Lancrin, S. (2022). Smart Education Technology: How It Might Transform Teaching (and Learning). New England Journal of Public Policy: 34(1): 5.

[98] Ibid.

[99] Digital Strategy Safer Internet Centres

Available evidence shows that infrastructural improvements are not always integrated and pedagogically used by schools across Europe[100]**.** Data from 2017-2018 indicated a low use of computers at schools, with one fifth of European ISCED level 2 students and one quarter of ISCED level 3 never or almost never[101] using a computer for learning[102]. Only about half of ISCED level 2 and 3 students (52% and 59%, respectively) used a computer at least once a week. With regards to the use of Internet, 68% and 73% of students at ISCED level 2 and 3 respectively used the Internet at school at least once a week. In parallel, PISA 2018 results show considerable disparities between countries in terms of the capacity of their schools to use digital technologies for teaching, while sometimes gaps were also present between advantaged and disadvantaged schools[103]. There is no recent large-scale study on the use of digital technologies in educational institutions at European or international level. Moreover, the literature reviewed does not provide much insight into the quality of teaching and learning when digital devices are used, failing to show consistent relationships between computer access, usage and educational outcomes.

The lack of planning and vision for integrating digital technologies was found in the 2020 public consultation to be one of the most significant challenges for digital education in Europe. As shown by the International Computer and Information Literacy Study (ICILS), teachers in schools that followed a collaborative approach to digital education were more likely to integrate digital technologies in their practice[104]. A whole-school approach can therefore be considered essential towards promoting innovative teaching and learning practices[105] that can have a lasting impact[106]. Stakeholders of the targeted consultations (2022) highlighted the need for such an approach through the development of school digital strategies that could facilitate the promotion of digital education in schools.

Pre-pandemic data show that only about one third of students across all ISCED levels attended schools with written statements on the use of digital technologies for learning[107]. The development of a school digital plan was a requirement only in a few educational systems in Europe, while in a few cases school digital plans were encouraged through the provision of

[100] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[101] As reported for the last three months prior to the survey.

[102] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

[103] OECD (2020). PISA 2018 Results (Volume V): Effective Policies, Successful Schools. In PISA. Paris: OECD Publishing.

[104] European Commission (2014). The International Computer and Information Literacy Study (ICILS):

Main findings and implications for education policies in Europe. Luxembourg: Publications Office of the European Union.

[105] Cachia R., Ferrari A., Ala-Mutka K., Punie Y. (2010). Creative Learning and Innovative Teaching: Final report on the study on creativity and innovation in education in the EU Member States. Luxembourg: Publications Office of the European Union.

[106] Ilomäki, L. and Lakkala, M. (2018). Digital technology and practices for school improvement: Innovative digital school model. Research and Practice in Technology Enhanced Learning 13, 25. https://telrp.springeropen.com/articles/10.1186/s41039-018-0094-8

[107] 31 % of ISCED level 1 students, 34 % of ISCED level 2 and 30 % of ISCED level 3

incentives, such as funds for digital infrastructure[108]. More recent evidence[109] indicates that there has been no major change in such requirements in recent years[110], while in the Structured Dialogue only a number of Member States mentioned the introduction of digital work plans in schools.

The use of the available digital technologies has not reached its full potential in higher education either, although Higher Education Institutions (HEIs) have an overall more advanced digital infrastructure than institutions of other educational sectors[111]. Higher education educators' age, role and discipline are parameters that affect the use of ICT in their teaching. Lack of time and support from their institutions are other factors that educators also find as limiting the use of digital technologies[112]. Practices that require more advanced digital pedagogical capacity, as for example using digital tools for collaborative or personalised learning and simulation-based learning, are less used[113]. The fact that HEIs across OECD countries have a high degree of autonomy, means that the level of their digital maturity is subject to the priorities and decisions of their leadership[114], limiting the possibility of central authorities to steer HEIs' digital education policy. However, central authorities can still incentivise and act as a driving force for HEIs in terms of their prioritisation and planning for digital maturity[115]. Further actions can be taken in terms of the professional development of academics as well (see section on "teachers' pedagogy skills").

Evaluation at an institutional level can also play a key role in further enhancing the use of digital technologies in schools. Assessment of the level of their "digital maturity", including the extent to which leaders and teachers, as well as students, have the ability to use ICT in teaching and learning processes, can inform the implementation of digital education, assist with the identification of gaps and, thus, maximise impact. Towards this end, the European Commission has developed a competence framework for citizens (DigComp[116]), for schools

[108] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[109] European Commission (2022). Education and Training Monitor 2022. Comparative report. Luxembourg: Publications Office of the European Union.

[110] The establishment of a school digital plan is a top-level requirement in only four countries (Ireland, France, Italy, and Portugal) and in another five countries (Spain, Latvia, Lithuania, Luxembourg and Austria) it is included in the school development plan.

[111] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[112] Ibid.

[113] Martin, F., Polly, D., Coles, S., & Wang, C. (2020). Examining higher education faculty use of current digital technologies: importance, competence, and motivation.

[114] Marshall, S. (2018), Shaping the university of the future: using technology to catalyse change in university learning and teaching, Springer.

[115] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[116] DigComp

(DigCompOrg[117]) and one for educators (DigCompEdu[118]). At the same time, collecting the views and concerns of stakeholders could also bring to light different needs and challenges inhibiting the use of technologies, as well as provide useful information on the types of support needed both at institutional and human capacity level[119].

A number of education systems in the EU encourage schools to assess their digital capacity as part of their internal self-evaluation, supporting them in the process[120]. Indicatively, in 2018-2019, the use of self-assessment tools for the evaluation of teachers' digital competences was promoted by 15 European education systems [121], while the use of self-assessment tools by schools (e.g. SELFIE[122]) or teachers (e.g. SELFIEforTEACHERS[123]) was present in about half of the Member States in the Structured Dialogue. Their use was also indicated as a supporting measure to facilitate schools' digitalisation by the stakeholders who took part in the 2022 targeted consultations. SELFIE is an example of a self-reflection tool, developed by the European Commission, which can be used by schools for the evaluation of their digital capacity. As regards the VET sector, over the last years, a new module on work-based learning has been developed as part of the SELFIE tool (SELFIE WBL), that helps bring VET institutions and companies closer together to discuss how to achieve a smart integration of digitalisation into work-based learning.

The selection of appropriate tools, data privacy and cybersecurity are additional issues in relation to which education institutions need support. To ensure that students are provided with high quality digital education, educational institutions need to be supported in selecting digital solutions that are tailored to their needs and have the potential to purposefully support teaching and learning[124]. Even in decentralised systems where educational institutions select their digital resources themselves and decide on how to use them, top-level authorities can still support them, for instance by offering access to centrally developed tools or providing guidance on the safe use of digital technologies in school[125]. During the Structured Dialogue Member States raised concerns about the ability of schools and other educational institutions to meet GDPR[126] obligations (considering the large amounts of data that stand under the responsibility

[117] DigCompOrg Framework

[118] DigCompEdu

[119] Ganimian, A., Vegas E. and Hess F. (2020). Realizing the Promise: How Can Education Technology Improve Learning for All?, Washington: The Brookings Institution.

[120] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[121] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[122] SELFIE

[123] SELFIE for TEACHERS | European Education Area (europa.eu)

[124] UNESCO (2022). Guidelines for ICT in education policies and masterplans. Paris: UNESCO.

[125] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[126] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data

of schools as "data controllers") and to ensure cybersecurity of their systems and users (particularly in the light of recent trends towards cloud-based and integrated tools and services). These are areas for which support at the level of the EU is sought. Currently, systems operate in an unpredictable manner, with Member States taking ad hoc measures such as the ban of certain applications for education in Germany[127] or in France[128]. Some stakeholders in the private sector therefore call for increasing trust and transparency in digital education by "whitelisting" digital education products and services at EU level, based on quality, privacy and security criteria.

Supporting learners' digital well-being emerged as an area of concern in both the CfE submissions and the Structured Dialogue discussions. Some respondents to the CfE highlighted the need to raise young people's awareness on potential harmful effects of the use of technology. In the Structured Dialogue, a few Member States cited examples of initiatives designed to promote safe and healthy use of digital technologies or address cyberbullying, while expressing their concerns about the digital well-being of students. These concerns suggest a need for a more co-ordinated approach to digital well-being across EU educational systems. The recently adopted Council Conclusions on supporting well-being in digital education[129] call for Member States to strengthen learners' and educators' well-being when designing national policies and strategies in digital education, raise learners' and educators' awareness of the potential risks in the digital world and support schools in the promotion of digital well-being.

Leadership and non-teaching staff

Effective leadership constitutes an essential parameter in boosting institutional capacity to integrate digital technologies, next to the availability of digital infrastructure and the establishment of policies directing the digitalisation process[130]. Teachers' attitudes towards digital education constitute a significant indicator of the application of digital technologies in teaching and learning[131]. The cultivation of positive attitudes that would motivate teachers to integrate digital technologies in their practice requires a cultural change in schools, which entails communicating clearly the significance of ICT integration, prioritising inclusiveness, facilitating the use of ICT by creating space for this purpose in the daily activities, as well as provision of training[132]. In this process, school leadership plays a crucial role.

Representatives of the formal education sector in the targeted stakeholder consultations (2022) called for additional support for headmasters, to ensure that they gain the

[127] Skelton Klovig, S (30 November 2022) Microsoft 365 banned in German Schools over privacy concerns. Retrieved from https://www.computerweekly.com/news/252527842/Microsoft-365-banned-in-German-schools-over-privacy-concerns

[128] Kundaliya, D. (21 November 2022) France bans Office 365 and Google Workspace in schools. Retrieved from https://www.computing.co.uk/news/4060509/france-bans-office-365-google-workspace-schools

[129] Council conclusions on supporting well-being in digital education, 2022 O.J. (C 469/04).

[130] Costa, P., Castaño-Muñoz, J. and Kampylis, P. (2021). Capturing schools' digital capacity: Psychometric analyses of the SELFIE self-reflection tool.

[131] Voogt, J., Knezek, G., Cox, M., Knezek, D., & ten Brummelhuis, A. (2013). Under which conditions does ICT have a positive effect on teaching and learning? A call to action. Journal of computer assisted learning, 29(1), 4-14.

[132] National Foundation for Educational Research (NFER). (2009). Using digital technologies to promote inclusive practices in education.

necessary skills to promote digital education in their schools. In 2018 only one third of European education systems included explicitly in their national strategies specific measures towards the training of school leaders[133]. The Structured Dialogue showed that even four years later only a few Member States were implementing programmes specifically targeted at school or institutional leaders to enable them to support the digital transformation of their school, placing an overall lower emphasis on training provision to school leaders relative to teachers.

Moreover, inadequate pedagogical and technical support for teaching staff is perceived by teachers as a significant obstacle to the incorporation of digital technologies in teaching and learning[134]. Teachers' feedback[135] highlighted insufficient awareness, lack of the required knowledge, skills and confidence, and difficulty to keep up to date with continuous technological development. Teacher training, promotion of trustworthy resources and more campaigns targeting parents and carers are needed. A lack of pedagogical models on how to use ICT for learning is also reported as another barrier. In PISA 2018, only about half of the principals of 15-year-old students (54%) across OECD countries reported an adequacy of qualified technical assistant staff in their schools, with the shortages being more prominent in disadvantaged schools[136]. At EU level the figures were similar (see Figure 3 of the previous section). At the same time, only 67% of the principals of 15-year-old students in EU countries found that sufficient professional resources were available to teachers to learn how to use digital technologies, with the figures illustrating again an average larger insufficiency in disadvantaged schools[137].

An emerging term used by educational systems in this regard is that of the "digital or ICT coordinator". In 2018 about half of the educational systems in Europe had policies supporting the appointment of digital coordinators in schools[138], while more recent data from the Education and Training Monitor 2022[139] show that in only 10 EU education systems appointing digital coordinators in schools constitutes a top-level requirement[140]. A common practice in the European education systems is to assign the role of the ICT coordinator to ICT teachers or teachers with a specialisation in ICT; this may also involve the reduction of their teaching hours[141]. The responsibilities of ICT coordinators vary across Member States and between

[133] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[134] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

[135] European Commission (2022). How to make Europe's Digital Decade fit for children and young people?: A report from the consultation with children and young people. European Union.

[136] OECD (2020). PISA 2018 Results (Volume V): Effective Policies, Successful Schools. In PISA. Paris: OECD Publishing.

[137] Ibid.

[138] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[139] European Commission (2022). Education and Training Monitor 2022. Comparative report. Luxembourg: Publications Office of the European Union.

[140] The Flemish Community of Belgium, Spain, France, Italy, Cyprus, Luxembourg, Malta, Austria and Slovenia.

[141] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

schools of the same country, but usually they are responsible both for the provision of technical and pedagogical support in their school[142]. Many Member States in the Structured Dialogue recognised that such ICT support should not be limited to only including the technical aspect, but to also involve pedagogical guidance in the use of digital tools in teaching, learning and assessment and support in the development and implementation of school digital plans. The crucial role of ICT coordinators was emphasised by the stakeholders in the targeted consultations (2022), who saw space to further develop and professionalise this emerging role.

Teachers' digital pedagogy skills

The positive impact of the use of digital technologies in schools is equivalent to teachers' and educators' ability to integrate them effectively in the learning process[143] and take advantage of their possibilities to transform and enrich their teaching[144]. As the literature indicates, "*it is not whether technology is used (or not) which makes the difference, but how well the technology is used to support teaching and learning"*[145].

To achieve this positive impact in teaching and learning teachers need to have the necessary competences and positive attitudes that would enable them to use the digital tools effectively[146] and develop "digital pedagogies" that support learning[147]. According to findings from the International Computer and Information Literacy Study (ICILS), teachers with higher confidence about their capability in using ICT were more likely to support the development of their students' ICT skills than less confident teachers[148] [149]. It is noteworthy that if not used appropriately, digital tools may even cause distraction to students, and thus negatively affect the teaching process[150]. To be able to deploy appropriate pedagogical strategies when using digital resources, teachers need to have sufficient Technological

[142] The role of an ICT coordinator may involve supporting teachers in using digital tools as well as embedding them into their teaching, managing the school digital platforms, providing training to teaching staff, assisting in the development and implementation of a school digital plan, as well as the promotion of digital education activities (European Commission, 2019b).

[143] Comi, S., Argentin, G., Gui, M., Origo, F. & Pagani, L. (2017). Is it the way they use it? Teachers, ICT and student achievement, Economics of Education Review, 56, 24-39.

[144] Redecker, C. (2017). European Framework for the Digital Competence of Educators: DigCompEdu. Luxembourg: Publications Office of the European Union.

[145] Låg, T., & Sæle, R. G. (2019). Does the flipped classroom improve student learning and satisfaction? A systematic review and meta-analysis. AERA open, 5(3).

[146] Conrads, J., Rasmussen, M., Winters, N., Geniet, A., Langer, L. (2017). Digital Education Policies in Europe and Beyond: Key Design Principles for More Effective Policies. Redecker, C., P. Kampylis, M. Bacigalupo, Y. Punie (ed.). Luxembourg: Publications Office of the European Union.

[159] Låg, T., & Sæle, R. G. (2019). Does the flipped classroom improve student learning and satisfaction? A systematic review and meta-analysis. AERA open, 5(3).

[148] Fraillon, J., Ainley, J., Schulz, W., Friedman, T. & Gebhardt, E. (2014). Preparing for Life in a Digital Age: The IEA International Computer and Information Literacy Study International Report. Heidelberg: Springer International Publishing.

[149] Fraillon, J., Ainley, J., Schulz, W., Friedman, T. & Duckworth, D. (2020). Preparing for Life in a Digital Age: The IEA International Computer and Information Literacy Study International Report. Amsterdam: Springer International Publishing.

[150] OECD (2019). How's Life in the Digital Age? Opportunities and Risks of the Digital Transformation for People's Well-being. Paris: OECD Publishing.

Pedagogical and Content Knowledge (TPACK)[151]. The use of ICT in the educational process proves especially important for educators who teach students with special educational needs (SEN). Lack of digital skills and competences to use ICT in their teaching may weaken their capacity to support SEN students' learning and inclusion.

However, available evidence demonstrates significant shortages in European educators' digital skills. PISA 2018 showed that across OECD countries on average only 65% of 15-year-old students had teachers with the necessary technical and pedagogical skills to use ICT in teaching and learning[152]. At the same time, the results of the 2018 OECD Teaching and Learning International Study (TALIS)[153] revealed that there was a significant number of EU teachers who resisted innovation; 72% of teachers reported that most teachers at their school were open to innovation. Data from the same year show that only 19% of ISCED level 1, 15% of ISCED level 2 and 30% of ISCED level 3 students had teachers who used digital technologies in more than 75% of lessons, with wide variations across EU countries[154]. One fifth of educators (20.4%)[155] who responded to the public consultation (2020) reported that during the pandemic they had insufficient digital skills and competences.

The lack of teachers' skills in using ICT in the educational process is perceived by teachers as a significant obstacle to 'progress in ICT in education'[156]. TALIS 2018 results suggested that provision of training is beneficial to the use of ICT in the teaching process. Teachers who had received relevant training or collaborated on a regular basis with their colleagues, used digital technologies more frequently and had more confidence in supporting their students with ICT. Training is therefore an important contributing factor towards increasing the use of the available digital infrastructure in schools[157]. The need to equip educators and teachers with digital competences was identified by the public consultation (2020) respondents as the most important element in the provision of digital education, while teacher training and guidance prevailed as one of the most pressing challenges for digital education. The need for teacher training opportunities was recognised as particularly important throughout the consultations of 2022 and in most cases it was highlighted as the top priority.

While VET teachers are slightly more likely to use ICT than teachers in general education, there remains ample scope for further teacher training. In TALIS 2018, 74% of upper

[151] Ulferts, H. (ed.). (2021). Teaching as a Knowledge Profession: Studying Pedagogical Knowledge across Education Systems, Educational Research and Innovation. Paris: OECD Publishing.

[152] OECD (2020). PISA 2018 Results (Volume V): Effective Policies, Successful Schools. In PISA. Paris: OECD Publishing.

[153] OECD (2019). TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners, Paris: OECD Publishing.

[154] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

[155] 20.4% in the sample "All countries" and 18.8% in the sample "Without RO".

[156] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[157] Gil-Flores, J., J. Rodríguez-Santero and Torres-Gordillo, J. (2017). "Factors that explain the use of ICT in secondary-education classrooms: The role of teacher characteristics and school infrastructure", Computers in Human Behavior, 68, 441-449.

secondary VET teachers of six OECD countries and regions that provided available data[158], stated that they used digital tools in teaching, while general education teachers presented a lower share of 66%[159]. This is in line with evidence from the European Commission's SELFIE tool, which indicates that VET teachers are slightly more likely to declare use of ICT in their teaching than general education teachers[160]. Despite the quite broad use of digital tools in VET education, about half (46%) of VET teachers of the countries and regions with available data highlighted digital skills as the area where training is needed the most[161]. For educators of higher education, although there is an evident need for training in ICT skills for teaching, the fact that many perceive teaching as less prestigious than conducting research[162], implies that they have a low motivation to take part in relevant training[163].

Following the first wave of policy measures to promote digital education which prioritised the provision of digital infrastructure, the focus of many educational systems has turned to the development of digital capacity of teachers[164]. In 2018 digital competences were included among the essential competence criteria for all teachers in the teacher competence frameworks of about two thirds of the European educational systems, with some countries having adopted a framework specifically focusing on teacher-specific digital competences or standards[165]. In the Structured Dialogue teacher training was a central topic in discussions with all Member States. Most comments focused on Initial Teacher Education (ITE) and Continuous Professional Development (CPD) in primary and secondary education levels, while less significance was attached to supporting the development of digital pedagogies for educators in the Higher Education or VET sectors.

Stakeholders from the formal education sector particularly highlighted the importance of offering support to educators in both ITE) and CPD. The purpose is to enable them to use digital technologies in teaching and learning in a meaningful and efficient way. Across OECD countries, only 56% of lower secondary teachers who participated in TALIS 2018 were trained in the use of digital technologies in teaching as part of their ITE programme, with the share being considerably higher among teachers who more recently completed their studies. At the same time, only 43% felt well or very well prepared to use digital resources for teaching when

[158] In the context of the TALIS analysis VET teachers were defined as those who declared teaching practical and vocational skills in the year of the survey. The type of their programme or school was not considered. Data was available for Sweden, Portugal, Denmark, Slovenia, Canada (Alberta) and Türkiye (OECD, 2021).

[159] OECD (2021). Teachers and Leaders in Vocational Education and Training, OECD Reviews of Vocational Education and Training. Paris: OECD Publishing.

[160] Ibid.

[161] Ibid.

[162] Blackmore, P. and Kandiko, C. (2011). Motivation in academic life: a prestige economy, Research in Post-Compulsory Education, 16:4, 399-411.

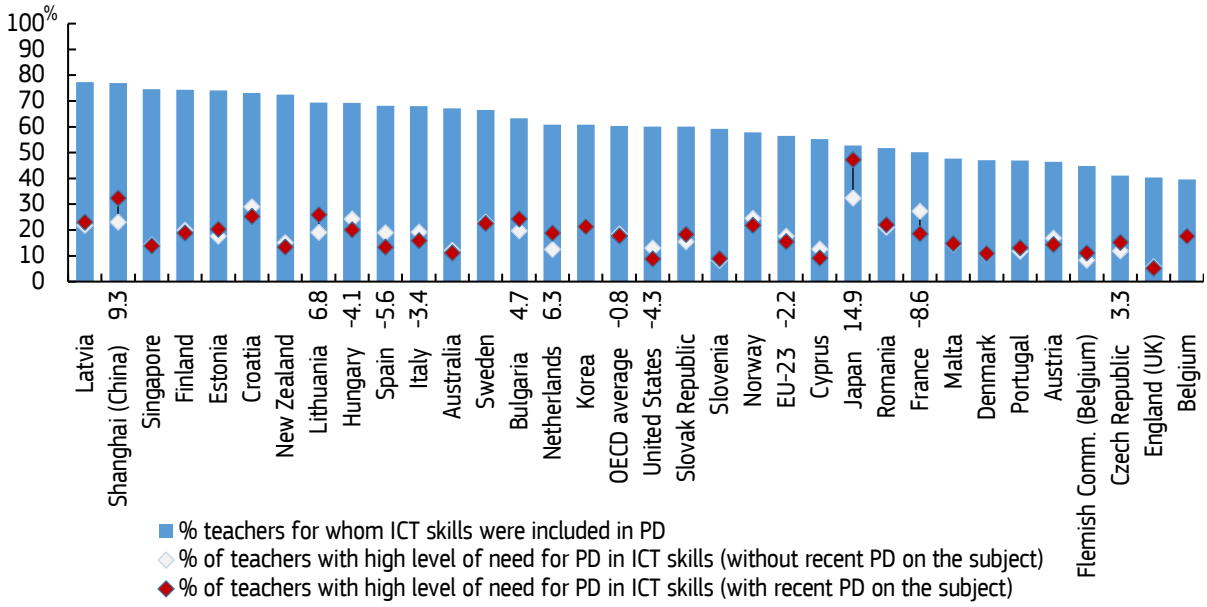
[163] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[164] Conrads, J., Rasmussen, M., Winters, N., Geniet, A., Langer, L. (2017). Digital Education Policies in Europe and Beyond: Key Design Principles for More Effective Policies. Redecker, C., P. Kampylis, M. Bacigalupo, Y. Punie (ed.). Luxembourg: Publications Office of the European Union.

[165] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

graduating[166]. As regards teachers' in-service training, in TALIS 2018 lower-secondary teachers classified ICT skills for teaching as the second most-needed area for professional development[167]. 60% of those stated that they had received training on digital skills for teaching during the past year (57% across the EU), with 17.6% (of those who participated in training) expressing a high need for further professional development in this area. Educators' participation in training on digital skills and need for such training presents heterogeneity across OECD countries (see Figure 4)[168].

Figure 4: Teachers' participation in and need for professional development in ICT skills (2018)



Notes: Countries and economies are ranked in descending order of the proportion of teachers that engaged in professional development activities on ICT skills for teaching in the 12 months prior to the survey; Statistically significant differences between teachers for whom ICT skills for teaching was included in their professional development activities and teachers for whom it was not included are shown next to the country/economy name.
Source: OECD (2019), TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners, Table I.5.24[169].

Evidence collected through the Structured Dialogue indicates that Initial Teacher Education (ITE) in most Member States includes a mandatory or core component on digital pedagogies. There are some instances of Member States where digital pedagogy is either non-mandatory, or its inclusion in the study programme is currently under review. ITE in most Member States is provided in HEIs, most of which have autonomy over their curricula

[166] OECD (2019). TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners, Paris: OECD Publishing.

[167] The most widely reported need for training was teaching students with special educational needs.

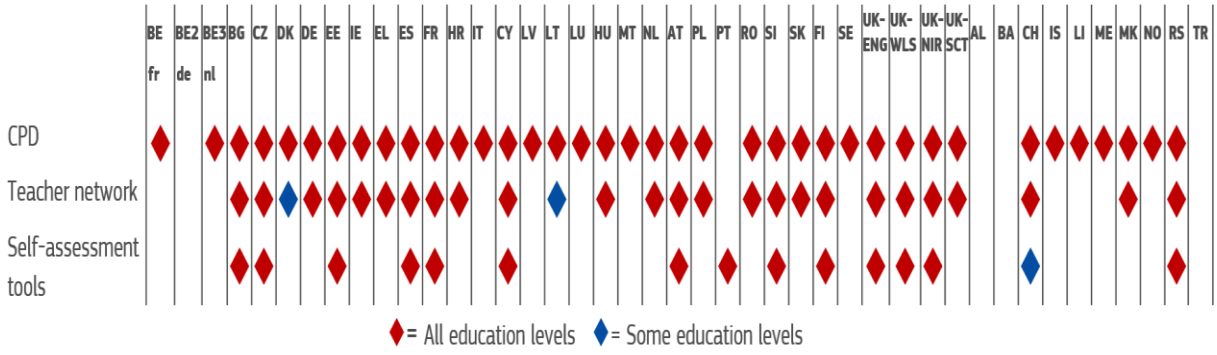
[168] OECD (2019). TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners, Paris: OECD Publishing.

[169] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

and training content. The autonomy of HEIs in defining teacher training curricula has slowed down the introduction of digital pedagogy skills into the initial training of teachers in several countries, as it cannot be centrally mandated. There is a need to further improve the ITE training offer in Member States and ensure its more consistent implementation with regard to digital pedagogies.

Pre-Covid data (2018) showed that almost all educational systems in Europe support the development of teachers' digital competences through different continuous professional development activities (see Figure 5)[170]. In most European educational systems, a certain amount of in-service training is mandatory[171], however the decision on the subject matter of the training usually lies with the schools[172]. This implies that it is not obligatory for teachers to participate in training specifically on improving their digital skills, if this is not a top-level requirement. When it comes to educators of higher education, participation in trainings is not mandatory in the majority of EU countries[173]. In the VET sector, for 19 EU countries CPD is mandatory, although not all specify the content of CPD programmes VET educators are required to take[174].

Figure 5: Methods of supporting the continued development of teacher-specific digital competences, primary and general secondary education (ISCED 1-3), 2018/19[175]



Source: Eurydice report (European Commission, 2019)[176]

[170] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[171] European Commission/EACEA/Eurydice (2018). Teaching Careers in Europe: Access, Progression and Support. Eurydice Report. Luxembourg: Publications Office of the European Union.

[172] European Commission/EACEA/Eurydice (2015). The Teaching Profession in Europe: Practices, Perceptions and Policies. Eurydice Report. Luxembourg: Publications Office of the European Union.

[173] OECD (2019). Benchmarking Higher Education System Performance. Higher Education. Paris: OECD Publishing.

[174] Cedefop (2022). Teachers and trainers in a changing world: building up competences for inclusive, green and digitalised vocational education and training (VET): synthesis report. Luxembourg: Publications Office. Cedefop research paper, No 86.

[175] Only methods supported by top-level authorities are considered.

[176] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

Educational systems offer CPD activities in different ways, such as the provision of courses through national or regional CPD institutions or the allocation of funding to public or private training providers[177]. As shown in Figure 5, educational systems combine different approaches in supporting the development of digital competences of teachers (i.e. CPD activities, teacher networks and self-assessment tools). CPD courses may be delivered either face-to-face or online, including Massive Open Online Courses (MOOCs). The content of training courses may include several topics, ranging from basic ICT skills to the pedagogical use of digital tools in different school subjects. For example, the Commission, under the new European strategy for better internet for kids, is developing MOOCs for teachers for different age groups of pupils with lessons on media literacy, online safety and consumer risks online[178]. In most of the cases where digital competences form part of the teacher competence frameworks, educational systems promote their use, while also providing CPD opportunities[179]. Some stakeholder submissions to the CfE reflected the view that professional development in digital pedagogies should be viewed through the broader lens of CPD more generally.

The Structured Dialogue discussions showed that, building on the learnings of the pandemic, many Member States have, or are in the process of, implementing CPD programmes for educators at a large scale, using online tools, often in combination with other formats (e.g. face-to-face training, digital platforms to enable collaborative exchange). However, CPD in VET and Higher Education received a lower focus relative to primary and secondary levels, implying a need for further prioritisation and co-ordinated approaches to teacher training in those sectors. A recent report of the European Centre for the Development of Vocational Training (CEDEFOP) outlines a variety of CPD programmes on improving the digital skills of VET teachers across several Member States, stressing that in the aftermath of the pandemic CPD on digital skills has been considered a priority[180]. Other relevant supporting efforts include increasing the attractiveness of VET teaching, improving the quality of teacher training provision and enhancing the pedagogical preparedness of VET educators. In higher education, actions that have been taken worldwide include for instance the establishment of national centres providing programmes and resources to enhance the teaching skills of academics[181], as well as efforts to enhance the prestige of teaching through several ways, such as including teaching quality in HEIs' strategic priorities or offering awards for excellence in teaching[182].

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[177] Ibid.

[178] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Digital Decade for children and youth: the new European strategy for a better internet for kids (BIK+), COM/2022/212 final.

[179] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[180] Cedefop (2022). Teachers and trainers in a changing world: building up competences for inclusive, green and digitalised vocational education and training (VET): synthesis report. Luxembourg: Publications Office. Cedefop research paper, No 86.

[181] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[182] Hénard, F. and Roseweare D. (2012). Fostering quality teaching in higher education: Policies and practices. Paris: OECD Publishing.

A key challenge for some Member States is the perceived mismatch between the training offer and the needs of educators. As highlighted during the Structured Dialogue and the feedback to the CfE, there is a need to tailor digital education training to the different roles and skills levels of teachers. This need is further exacerbated by the fact that most Member States do not currently have a process in place to assess or monitor teachers' digital pedagogical skills (or digital skills). While it is acknowledged by some Member States that international studies such as TALIS and ICILS provide valuable insights into the education system, these sources do not provide the required information for matching training offers to teachers' needs. The development of a more comprehensive approach to the assessment of teachers' needs would thus be beneficial. In parallel, CPD courses should not be limited to technical teaching skills, but they should also cover digital pedagogy and its adaptation to different subjects, and address the specific needs of students (e.g. use of assistive technologies for SEN students)[183]. This approach can enable teachers support "learning with technology" by integrating ICT in a cross-curricular manner, aiming at facilitating students' learning[184]. They can also support "learning from and through technology" by using digital technologies as an information source and means of learning. In this way, teaching and learning is not limited to the mere use of technology to improve students' digital skills ("learning about technology")[185].

Stakeholders who responded to the CfE highlighted the need to strengthen the provision of teacher professional development on digital pedagogy. Some called for more investments, while a few stressed also the need to encourage participation in teacher training, as well as the recognition of teachers' efforts. This was underlined by the stakeholders of the targeted consultations (2022) as well, suggesting the provision of incentives to teachers to engage in training on digital pedagogy. Incentives may include financial benefits, career development, reduction of teaching hours, prizes, etc.[186]. Other ways that can act as drivers to engage in digitally enhanced teaching is through the inclusion of digital competencies in professional standards for teachers or certification frameworks that promote recognition of their skills[187].

An aspect that should be taken into account in this regard is the lack of dedicated time for professional development, which was also reported by the stakeholders as a discouraging factor for educators to engage in training. As demonstrated in PISA 2018, on average across OECD countries only for 60% of 15-year-old students their principal mentioned sufficient time of the school's teachers for lesson preparation that includes the use of digital tools[188]. It is noteworthy that even though digital technologies and platforms facilitate some elements of

[183] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[184] Lloyd, M. (2005). Towards a definition of the integration of ICT in the classroom. In AARE 2005, AARE, Eds. Proceedings AARE '05 Education Research - Creative Dissent. Parramatta, New South Wales: Constructive Solutions.

[185] Ibid.

[186] Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., & Monseur, C. (2013), The use of ICT in education: A survey of schools in Europe, European Journal of Education, 48(1), 11-27.

[187] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[188] OECD (2020). PISA 2018 Results (Volume V): Effective Policies, Successful Schools. In PISA. Paris: OECD Publishing.

teachers' work, navigation of the available resources and planning for lessons that embrace digital pedagogy requires time[189]. This signals the importance of sufficient time allocation for teachers for preparing digitally-enhanced lessons.

Literature indicates that flexible and innovative teacher training formats, such as job-shadowing, national and international staff exchanges, peer learning, and communities of practice, have more impact and longer-lasting effects than traditional training formats. The creation of communities of practice was identified as an effective way to provide support to teachers and encourage exchange of practices by participants of the targeted consultations (2022). Some teachers across Europe seem to opt for the informal learning provided by such communities. According to 2018 data, 41% of primary level and 29% of lower secondary level students had teachers who had taken part in an online community for professional development on ICT during the past two years[190]. As Figure 5 illustrates, about two-thirds of the European education systems had already established teacher networks on ICT in education. The development of communities of practice can take place at different levels (i.e. European level, national level, regional or school level). European platforms, such as the e-Twinning[191], can provide a variety of opportunities for collaboration and learning across teachers of Europe, while national and regional authorities can establish teacher networks and develop national digital platforms for teachers (this could also be achieved through funding external institutions to provide those services)[192]. At school level, leaders could encourage the creation of in-school communities of practice targeted to supporting teachers in addressing commonly identified needs for change and promoting innovation in the school environment[193]. A proactive and pedagogically skilled leadership is essential for promoting a school culture that stimulates teacher collaboration and professional development[194].

It is noteworthy that the Structured Dialogue discussions on teacher training opportunities in digital pedagogies tended not to include references to their actual or expected impact, whether on teachers or students. At the same time there were not many references across Member States on efforts taken to ensure continuity of teacher training provision. Training that takes the form of single courses or courses that are provided for a short

[189] Minea-Pic, A. (2020). Innovating teachers' professional learning through digital technologies, OECD Education Working Papers, No. 237. Paris: OECD Publishing.

[190] European Commission (2019). 2nd Survey of Schools: ICT in Education - Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

[191] eTwinning

[192] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[193] OECD (2019). TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners, TALIS, Paris: OECD Publishing.

[194] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

period of time usually have a low impact on educational outcomes[195] [196]. This rather fragmented and ad-hoc nature of support for teacher learning and development may be underpinned by a range of factors, including the non-mandatory nature of CPD in many Member States. Similarly to investments in digital infrastructure, investments in teacher training should follow a forward-looking approach in order to be impactful.

3. Digital education policy

3.1. Development and implementation

Digital education and training strategies

While efforts to date have focused on the availability of digital technologies and tools, less emphasis has been placed on the policy framework that can enable innovation and support an inclusive and effective use of digital technologies[197]. An upcoming report by the OECD finds that a strategic vision for digital education supported by impact-focused investments, comprehensive governance and concrete policy implementation has not yet been fully adopted by all its member countries[198]. While the majority of EU countries had already included digital education elements in their policy orientations even prior to the COVID-19 pandemic[199], respondents to the 2020 public consultation considered these efforts insufficient and underscored the need for a more strategic and consistent approach to digital education in Europe.

Prior to the COVID-19 pandemic, less than half of EU countries had a specific strategy for digital education, with only little progress having been made more recently[200]. A lack of a strategic focus to digital education is evident even in cases where digital education strategies are in place.

In light of the lessons learnt from the pandemic, as well as the strong emphasis on the digital transformation in the EU's Recovery and Resilience Facility (RRF), the digital dimension has recently gained greater prominence in EU Member States' policies. The Structured Dialogue showed that Member States tend to have a high number of distinct strategies for the digital transformation, which sometimes even include separate digitalisation strategies for different sectors or levels of education. An emerging trend is for countries to adopt overarching digital transformation strategies, which attempt to bring together all government efforts to promote digitalisation across sectors, e.g. in the economy, public administration and

[195] Glazerman, S., Isenberg, E., Dolfin, S., Bleeker, M., Johnson, A., Grider, M. & Jacobus, M. (2010). Impacts of Comprehensive Teacher Induction: Final Results from a Randomized Controlled Study (NCEE 2010-4027), US Department of Education, Institute for Education Sciences.

[196] Garet, M. S., Heppen, J. B., Walters, K., Parkinson, J., Smith, T. M., Song, M., Garrett, R., Yang, R., & Borman, G. D. (2016). Focusing on mathematical knowledge: The impact of content-intensive teacher professional development (NCEE 2016-4010), U.S. Department of Education, Institute of Education Sciences.

[197] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[198] Ibid.

[199] Ibid.

[200] Ibid.

education and skills. However, such strategies often simply provide an overview, while the implementation continues through specific sectoral strategies and measures, without benefitting from cross-sectoral collaboration and the synergies and efficiencies this could bring. Moreover, although broader strategies serve the purpose of better aligning digital education with wider educational or societal objectives, they often address digital education in a less comprehensive way, overshadowing it by encompassing only some of its aspects[201], for example by focussing only on digital skills acquisition[202]. Such an approach largely restricts the scope of digital education, as the use of digital technologies has the potential to advance educational outcomes more broadly[203].

Most commonly digital education strategies are not supported by concrete implementation plans[204]. The lack of specific time bound measures on putting the broader objectives into practice and mechanisms for monitoring the implementation may risk limiting the impact of policies. Moreover, while data on the funds allocated to implementing digital education strategies is limited, available information about the resources of broader digital transformation strategies shows an inadequacy of funding mechanisms for the majority[205].

Finally, it is commonplace that countries that had introduced digital education strategies prior to the pandemic have neglected to renew them upon their expiration. Regular revisions of the strategies should take place as naturally as technological advances to allow for a better alignment of the associated investments and the governmental strategic objectives[206]. In the majority of OECD countries, more advanced digital technologies (e.g. AI, Blockchain, etc.) are rarely mentioned in digital education strategies[207]. The importance of continuity of reforms and investments in digital education was particularly emphasised in the 2022 stakeholder consultations as well.

Coordination across sectors and levels of government

The planning and implementation of digital education and training strategies presents a new challenge in this policy field, as it necessitates collaboration and coordination with multiple sectors of government, most notably those responsible for infrastructure, finance, research and employment. Recently, various organisations have proposed frameworks aiming to give policy-makers a blueprint for designing comprehensive digital education policy ecosystems. Some notable examples include the Organisation for Economic

[201] Ibid.

[202] van der Vlies, R. (2020). Digital strategies in education across OECD countries: Exploring education policies on digital technologies. OECD Education Working Papers, No. 226. Paris: OECD Publishing.

[203] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[204] van der Vlies, R. (2020). "Digital strategies in education across OECD countries: Exploring education policies on digital technologies", OECD Education Working Papers, No. 226. Paris: OECD Publishing.

[205] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[206] Ibid.

[207] Ibid.

Cooperation and Development[208] and the European Training Foundation[209]. Such theoretical frameworks demonstrate the role of policy areas other than the educational sector and the need for coordination with them, as was also reflected in the contributions from stakeholders who participated in the 2022 consultations and called for a holistic approach to digital education.

An example of such a whole-of-government approach at the European level is the High Level Group of National Coordinators for the Structured Dialogue on Digital Education and Skills. The Member State representatives nominated as national coordinators were given the mandate to represent the relevant departments in their countries responsible for different aspects of digital education, training and skills (including education, labour, digital, industry and finance). Similarly, participants in the bilateral meetings included government officials from many different ministries and government agencies in every country, and often commented that participation in the Structured Dialogue was the first time they met in a structured way at the national level.

In the Structured Dialogue, Member States also recognised that national, regional and local structures that enable whole-of-government approaches should be a key factor in enabling the successful development and implementation of digital education policies. A majority of them noted that they are willing to continue using the newly established lines of communication and collaboration, which had arisen in response to the pandemic, across government and other levels of the system, as well as with social and industry partners. However, while a majority of Member States recognise the importance of whole-of-government approaches to digital education, **in practice such coordination efforts are experienced as very challenging and frequently technically complex, in particular at the implementation and monitoring stages.**

Member States with regional governance structures and high levels of local autonomy also emphasised coordination challenges across governmental levels. For instance, some countries where the governance of education and training systems is devolved to the regions pointed to challenges in obtaining a comprehensive overview of the overall situation with digital education, when teacher education and training is not within the responsibility of the central authorities. Decentralisation has incrementally become very common across EU countries in the recent years; demonstrated by increased school autonomy and involvement of different entities in the education governance (e.g. education inspectorates, professional development organisations, etc.), resulting in "multi-level decision-making processes" with inconsistent links among the different levels[210]. A strategic vision for digital education along with the corresponding implementation mechanisms should facilitate the distribution of responsibilities among the different governmental levels, other relevant bodies as well as educational institutions and enable cooperation among them[211]. In the 2022 EU Week of

[208] Ibid.

[209] ETF Digital Education Reform Framework

[210] Burns, T. & Köster, F. (2018). Educational Research and Innovation Governing Education in a Complex World, Educational Research and Innovation. Paris: OECD Publishing.

[211] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

Regions and Cities workshop on digital education and skills the need of empowering local and regional authorities in managing investments in digital education and skills was underlined.

Digital education strategies across EU countries present a lack of explicit coordination mechanisms and distribution of responsibilities among the different actors and bodies involved in the development, implementation and monitoring of digital education policies[212]. In cases where digital education is included in broader digital strategies, allocation and coordination of responsibilities is likely to be more fragmented[213]. It is a common practice for countries to assign such responsibilities to a digital affairs ministry or body, while there are fewer cases where the responsibility is allocated to an above-ministerial body with a better capacity in coordinating policies[214]. As regards the implementation of digital education policies, evidence from 2018-2019 indicates that many European countries had assigned this responsibility to an agency outside the ministry of education or had established for this purpose a new external agency[215].

Involvement of stakeholders

In addition to different parts of government, the development of meaningful digital solutions and their widespread adoption greatly depend on the involvement of, and ownership by, many relevant stakeholders. As the European Commission's Digital Education Action Plan stresses, promotion of a high-quality and inclusive digital education requires an ecosystem approach, involving a collective effort of actors across all governmental levels, education and training institutions, and the private and public sector[216]. The need for a well-functioning and inclusive digital education ecosystem that would ensure cooperation at different levels also received wide recognition across all groups of stakeholders of the 2022 consultations.

In the Structured Dialogue, actions and initiatives that incorporated engagement between actors in the digital education ecosystem appeared in about one-third of topic instances and across all Member States, reflecting widespread engagement practices at various levels (practices are not limited to the decision-making processes). A majority of those related to engagement among public actors within the education and employment sectors, very frequently with stakeholders (including trade unions, teacher representative bodies and inclusion actors) on issues relating to digital education, and in some cases, such as the higher education sector, cross-institutional engagement on digital education enablers (e.g. interoperability). Some noted the development of national or regional forums to facilitate discussion and share learning across digital education issues. However, a number of Member States highlighted challenges in

[212] Ibid.

[213] Ibid.

[214] Gierten, D. and Lesher, M. (2022). "Assessing National Digital Strategies and their Governance", OECD Digital Economy Papers, No. 234, Paris: OECD Publishing.

[215] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[216] Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions, Digital Education Action Plan 2021-2027: Resetting education and training for the digital age, COM/2020/624 final.

involving all stakeholders in digital education and skills reforms, particularly in countries with regional governance arrangements.

Social partners, as representatives of workers and employers have a specific role to play in digital education and skills. Member States should further promote social dialogue and involve social partners in the design, implementation and evaluation of employment policies, including in projections and identification of training needs to develop skills intelligence. At the same time, Public Employment Services play a crucial role in promoting the early identification of skills shortages and trends linked to growing job opportunities, in devising national skills strategies, identifying skills shortages and job opportunities, and they are increasingly involved in guidance and supporting skills provision. Therefore, their involvement in the digital education and training decision-making is vital.

Both research and stakeholder consultations indicate that stakeholders should be involved during the whole policy cycle, from the policy design to the implementation and monitoring phases[217]. Some stakeholders suggested the establishment of national mechanisms that would facilitate a cross-sectoral and cross-level dialogue, ensuring the involvement of the different governmental bodies and other stakeholders and reflecting the wide range of needs and priorities. Close attention should be paid to the involvement of educators in the decision-making processes, from the policy design to the implementation stage[218], fostering in this way ownership, as well as the involvement of the educational institutions. To ensure that provision of external support to educational institutions on improving their digital capacity is impactful, investments need to consider the actual needs they are aiming to cover (i.e. digital equipment, training, etc.). Educational systems should thus seek institutions' insights on their needs when planning investments on digital education.

Relationship with the private sector

When it comes to the involvement of the private sector in the digital education ecosystem, many Member States in the Structured Dialogue recognised the potential of working with the EdTech industry to further enhance digital educational infrastructure, tools and content, while a small number also noted examples of successful public-private partnerships. Responses to the public consultation (2020) showed that ad hoc partnerships were established during the pandemic, including the ministries of education and public authorities, as well as private entities, NGOs and other organisations, with respondents expressing a willingness to continue working with these partners in the future. The need to promote more public-private partnerships was also stressed by a small number of stakeholders' submissions to the CfE.

Nonetheless, concerns were expressed in the Structured Dialogue discussions by some Member States in terms of managing regulatory aspects of the EdTech industry and the influence that EdTech may have on education systems. At the same time, the stakeholders of the 2022 consultations underlined the need to prevent the risk of commercialising education. UNESCO's recent guidelines for ICT in education policies and masterplans suggests that digital

[217] Conrads, J., Rasmussen, M., Winters, N., Geniet, A., Langer, L. (2017). Digital Education Policies in Europe and Beyond: Key Design Principles for More Effective Policies. Redecker, C., P. Kampylis, M. Bacigalupo, Y. Punie (ed.). Luxembourg: Publications Office of the European Union.

[218] Schleicher A. (2020). TALIS 2018, Insights and interpretations. Paris: OECD Publishing.

solutions should be assessed on the basis of humanistic values and educational needs[219]. Governments could boost quality assurance through the encouragement of collaboration between the education sector and education technology providers[220]. To date the education sector has not been adequately involved in the development of digital education technologies, however the involvement of practitioners would be beneficial in ensuring a pedagogical dimension[221] and alignment of digital content to the real needs of learners and teachers[222].

As noted earlier, stakeholders of the targeted consultations (2022) also raised the issue of ensuring transparency and data protection. Similar concerns for the role of private entities were raised by the stakeholders' submissions to the CfE, referring to the importance of digital sovereignty, data protection and data privacy. In this regard, the concepts of "privacy by design" and "security by design" were advocated. On the other side, representatives of the private sector in the 2022 consultations called for cooperation between the public and private sector, while recognising the importance of their own role in promoting privacy and security in their products.

3.2. Monitoring and evaluation

National level evidence

In support of the education systems' efforts to reinforce digital education, evidence-based policy-making acts as a catalyst for the development of comprehensive and effective approaches[223]. A comprehensive monitoring and evaluation framework that is in alignment with the system's strategic vision for digital education and training is vital to assess progress in the digital transformation, the effectiveness of investments, as well as the impact on educational outcomes, so as to identify potential challenges and adjust strategies[224]. In the rapidly evolving digital education domain, regular monitoring and timely evaluation of policies and actions should play a pivotal role for the development of a high-performing and inclusive digital education and training ecosystem. Monitoring, evaluation and assessment activities were widely referenced in the Structured Dialogue (in 26 of 27 Member States, covering 18% of all topic instances relating to enabling factors discussed in the meetings), reflecting the high importance of this issue to Member States. The need for a systematic monitoring and evaluation of digital education policies was also strongly supported by the stakeholders participating in the 2022 consultations.

[219] UNESCO (2022). Guidelines for ICT in education policies and masterplans. Paris: UNESCO.

[220] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[221] European Agency for Special Needs and Inclusive Education, Weber, H, Elsner, A. Wolf, D., Rohs, M. & Turner-Cmuchal, M. (2022). Inclusive Digital Education. Odense: European Agency for Special Needs and Inclusive Education.

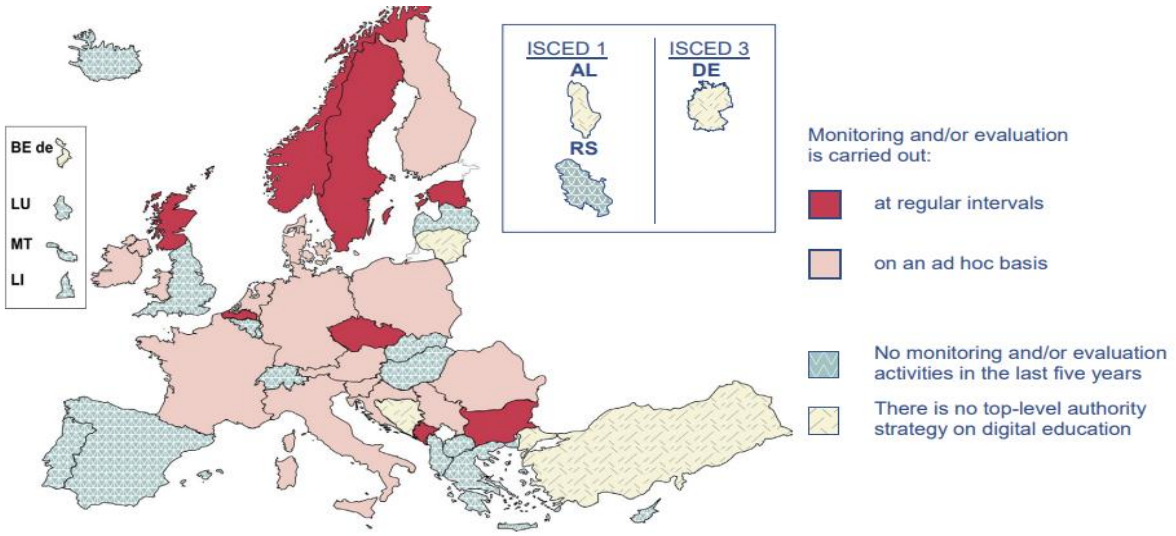
[222] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[223] Pellegrini, M., & Vivanet, G. (2021). Evidence-Based Policies in Education: Initiatives and Challenges in Europe. ECNU Review of Education, 4(1), pp. 25–45.

[224] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

However, evidence shows that systematic monitoring and evaluation of digital education strategies and policies is not yet a common practice in European educational systems (as shown in Figure 6)[225]. Around half of the countries surveyed in a 2018-2019 study had some type of such a practice in place, with only a few conducting it on a regular basis. Similarly, in the Structured Dialogue only about half of Member States mentioned monitoring activities within the broader implementation plans of their national strategies. At the same time, the discussions revealed a variation in the development of Member States' monitoring systems.

Figure 6: Monitoring and/or evaluation of digital education strategies and policies carried out in the last five years by top-level authorities, 2018/19



Source: Eurydice report (European Commission, 2019)[226]

Comprehensive monitoring systems and the development of innovative monitoring indicators are underway in a small number of Member States, while the majority follow a more ad hoc approach to monitoring. This is in line with OECD's recent data collection from September 2022 indicating some first efforts of more systematic monitoring by a number of countries[227], while challenges are still widespread across educational systems**.** As shown by the Structured Dialogue discussions, challenges in monitoring, evaluation and assessment were relatively high among Member States (28% compared to an average of 16% across topics, spread across 20 Member States). For instance, as mentioned earlier, a few Member States highlight difficulties in centrally auditing school devices and equipment. While some have systems in place (or are in the process of developing) to track infrastructural investments in educational institutions, several noted a lack of a national or regional system to monitor the use of equipment. Additionally, most of the cases of systematic monitoring and evaluation practices

[225] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[226] Ibid.

[227] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

concern school education, while the majority of countries still find it difficult to monitor digitalisation of HEIs in a consistent way[228].

The Structured Dialogue discussions demonstrated the use of external quality assurance mechanisms as a common practice for Member States, but digital education is not always covered. Schools are usually evaluated periodically by public inspectorates, while HEIs undergo external evaluation by public or private entities[229]. Teachers' use of digital technologies for example can be assessed through both internal and external evaluation practices[230]. However, according to the Education and Training Monitor 2022, external evaluations of schools do not usually include digital education criteria[231]. Only 13[232] out of the 23[233] Member States in which external evaluation is a top-level requirement have specific criteria on digital education. Such criteria can be related to the quality of digital infrastructure and the use of digital technologies both across the different school subjects and in the school management systems (i.e. channels facilitating communication with parents or other stakeholders, such as the school website, as well as management of virtual learning environments or collaborative digital tools)[234].

The use of self-assessment tools by schools (e.g. SELFIE & SELFIE WBL[235]) or teachers (e.g. SELFIEforTEACHERS[236]) is another way of monitoring and evaluating digital education. By the time of writing, SELFIE has been used by over 4.6 million users, involving 25,295 schools and 627,949 teachers in 84 countries. Uptake is especially prominent in Spain and Portugal, with 2.4 million users in Spain and 700,000 in Portugal, as national ministries of education actively promoted the use of SELFIE in schools. For the SELFIEforTEACHERS tool, over 100,000 primary and secondary teachers have completed a self-reflection to date with numbers growing steadily. Member States that reported using self-assessment tools in the Structured Dialogue had a positive impression of them. However, their use was present in only about half of the Member States and for the majority it tended to occur in a bottom-up approach. Some also sought support to further integrate the use of these tools more formally or extensively in monitoring and evaluation activities.

[228] Ibid.

[229] Ibid.

[230] OECD. (2019). PISA 2021 ICT Framework, retrieved from https://www.oecd.org/pisa/sitedocument/PISA-2021-ICT-Framework.pdf.

[231] European Commission (2022). Education and Training Monitor 2022. Comparative report. Luxembourg: Publications Office of the European Union.

[232] The Flemish Community of Belgium, Czechia, Germany, Estonia, Ireland (general lower secondary education), Spain, France, Lithuania, Hungary, Malta, Poland, Romania and Sweden.

[233] Bulgaria, Luxembourg, Austria and Finland do not conduct external evaluation of schools.

[234] European Commission/EACEA/Eurydice (2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[235] SELFIE

[236] SELFIE for TEACHERS | European Education Area (europa.eu)

Although the above practices indicate a range of data collection instruments and monitoring and evaluation mechanisms, in most countries the evidence base stems from ad hoc data collections, with only a few instances of periodic data gathering that allows monitoring of trends and impact over time[237]. Building an effective monitoring and evaluation framework for the digitalisation of education and training entails rigorous planning and long-term investment[238], and should be considered from the initial stages of the policy cycle. UNESCO's recent report on "Guidelines for ICT in education and masterplans" proposes an iterative approach to digital education policy-making, where each step informs the next one in the process, both in terms of "what works" and what the challenges are; this practice is especially important for digital education as technology is rapidly evolving[239]. Most importantly, it is vital to build a monitoring and evaluation infrastructure that is driven by the national strategic vision for digital education and training and the impact it is expected to make; focusing on the strategic objectives can set the ground for the identification of relevant targets and indicators[240].

Stakeholders of the targeted consultations stressed the importance of designing policies in a way that allows the evaluation of their impact. They particularly noted that it is crucial to move beyond measuring the output (e.g. provision of digital infrastructure) and focus on monitoring the outcome (e.g. impact on learning). In the context of investments in digital education specifically, stakeholders underscored the need for a clear definition of their expected impact and the indicators to be measured. Indicators of connectivity and infrastructure provide only part of the picture insofar, as information on the frequency and quality of usage of these resources for teaching, learning and assessment activities are most commonly not available.

EU-level evidence

From an EU perspective, the current gaps in the available evidence-base hinder impactful and efficient policy-making on digital education, as well as responding timely to the implications of emerging and disruptive technologies for education and training.

The scarcity of relevant national data is compounded by the infrequency of data collection at the international level. The use of large-scale international assessments to monitor the state of play in their digital ecosystems was mentioned by two-thirds of Member States in the Structured Dialogue[241]. However, as evidenced by the many instances of pre-pandemic data presented in this Staff Working Document, the majority of international and European studies appear only at very long time intervals, thus failing to keep pace with the rapidly evolving

[237] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[238] Ibid.

[239] UNESCO (2022). Guidelines for ICT in education policies and masterplans. Paris: UNESCO.

[240] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[241] Some Member States acknowledged that these studies cannot address all national monitoring and evaluation needs and that supplementary national data collection and monitoring activities are needed.

digital education domain. At the international level, the OECD's Programme for International Student Assessment (PISA) is conducted every three years, and The Teaching and Learning International Survey (TALIS) only every 5 years. The International Association for the Evaluation of Educational Achievement's International Computer and Information Literacy Study (ICILS) occurs at 5-year intervals. At the European level, the European Commission's Survey of schools on ICT in education has taken place twice; in 2011-2012 and in 2017-2018. Nowadays the evolution of digital education and training entails a much higher need for a data-driven policy, while at the same time updated evidence is not available on a regular basis.

In addition to their low frequency, existing international data systems present significant gaps in terms of the available evidence on most digital education dimensions, including for example the availability of digital infrastructure[242] and related investments, as well as the use of digital technologies in teaching and learning, limiting in this way countries' capacity to build an effective monitoring and evaluation infrastructure[243]. In the Structured Dialogue Member States commonly referred to challenges posed by the lack of systematic monitoring of device usage in schools and lack of data on teachers' digital pedagogical skills and related training needs.

Considering the available evidence supporting the development of comprehensive monitoring and evaluation systems in digital education and training policy, stakeholders of the targeted consultations stressed the need to conduct more research in the area of effective monitoring and develop appropriate indicators. An upcoming OECD study proposes a set of generic indicators for digital education that could be a basis for developing monitoring and evaluation systems at national and international level[244]. The list prioritises indicators for which recurrent data collection already exists, while recognising that the current national and international data collections do not cover the full digital education ecosystems and all enabling factors. Moreover, as noted previously, several key indicators are monitored only at very long intervals and are not always able to keep pace with technology developments.

In view of strengthening their evidence base, educational systems, besides adapting their existing data collection systems, could also benefit from the development of new data collections as well as new sources of data[245]. In this process several constraints need to be taken into account; collecting new data corresponding to all the different components of digital education can be a long process, requiring considerable financial and human capacity[246]. Moreover, the rapid development of technology does not always allow for timely analysis. Sources could include for example research studies, frameworks measuring educators' digital competences, surveys on teachers' and students' perceptions, self-evaluations of educational

[242] Connectivity is an area of digital infrastructure that is monitored relatively well.

[243] OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

[244] Ibid.

[245] Ibid.

[246] Ibid.

institutions, quality assurance evaluations, administrative data, etc.[247]. Data collection procedures could be supported through the use of learning analytics and big data from educational institutions[248], as well as through national and international cooperation platforms that facilitate exchange and better use of evidence[249]. When technology-supported monitoring practices are used, it is of paramount significance to follow policy frameworks that ensure a secure and ethical use of students' private data[250].

Overall, including a digital dimension to existing data collections, updating and repeating preceding studies, integrating relative international benchmarking, as well as using more qualitative data sources, could be used by educational systems as possible streams of evidence development for digital education to support their efforts in establishing an effective and comprehensive monitoring and evaluation infrastructure.

[247] Ibid.

[248] van der Vlies, R. (2020), "Digital strategies in education across OECD countries: Exploring education policies on digital technologies", OECD Education Working Papers, No. 226, OECD Publishing, Paris, https://dx.doi.org/10.1787/33dd4c26-en.

[249] Conrads, J., Rasmussen, M., Winters, N., Geniet, A., Langer, L. (2017). Digital Education Policies in Europe and Beyond: Key Design Principles for More Effective Policies. Redecker, C., P. Kampylis, M. Bacigalupo, Y. Punie (ed.). Luxembourg: Publications Office of the European Union.

[250] UNESCO (2022). Guidelines for ICT in education policies and masterplans. Paris: UNESCO.

PART II: DIGITAL SKILLS AND COMPETENCES

1. Digital skills: an overview of terms and concepts

Digital skills and their relevance today

The Digital Education Action Plan 2021-2027 puts the development of digital skills and competences as a priority for education and training systems. The Plan considers that digital skills are essential for life in a digitalised world and notes the ever-increasing demand for digital skills trigged by the digital transformation of society and the economy.[251]

The COVID-19 crisis showed very clearly the importance for everyone to be digitally skilled: 62% of respondents to the Open Public consultations held in preparation for the Action Plan felt that they had improved their digital skills during the crisis.[252] The Staff Working Document accompanying the New Skills Agenda considers digital skills to be part of basic skills, alongside literacy and numeracy, as they are indispensable in daily life for full and active participation in society and in the labour market.[253] The Staff Working Document accompanying the Digital Education Action Plan[254] claims that being digitally competent is both a necessity and a right.

Higher levels of digital skills are linked to better employability and learning. In the 2022 Amazon-Gallup Digital Skills Study[255], respondents with intermediate or advanced digital skills earn on average respectively 40 and 65 percent more than workers who do not use a computer at work – regardless of factors like gender and educational attainment. A study from 2016 on tenth-graders in Italy found that higher digital skills have a positive impact on academic achievement (with the effect being stronger for students with low academic performance or low family background).[256] This is supported by a 2022 study carried out at university level in France, which found that a high level of digital skills has a positive influence on student performance and the probability of achieving a high grade.[257]

Defining digital skills

Digital skills can be broadly defined as the ability to use technology and digital devices effectively, critically, efficiently and responsibly, to complete tasks and solve problems. The Council Recommendation on Key competences for lifelong learning (adopted in 2006 and updated in 2018) defines digital competence as the ability to confidently, critically and

[251] Communication from the Commission accompanying the Digital Education Action Plan 2021-2027 Resetting education and training for the digital age. COM/2020/624 final

[252] . Commission Staff Working Document accompanying the Digital Education Action Plan 2021-2027- SWD(2020) 209 final.

[253] Commission Staff Working Document accompanying a new skills agenda for Europe: Working together to strengthen human capital, employability and competitiveness, SWD/2016/0195 final

[254] Commission Staff Working Document accompanying the Digital Education Action Plan 2021-2027- SWD(2020) 209 final.

[255] Gallup & Amazon (2002). AWS Global Digital Skills Study. The economic benefits of a tech-savvy workforce. https://www.gallup.com/analytics/402284/aws-digital-skills-study.aspx

[256] Pagani, L., Argentin, G., Gui, M., & Stanca, L. (2016). The impact of digital skills on educational outcomes: evidence from performance tests. Educational studies, 42(2), 137-162.

[257] Ben Youssef, A., Dahmani, M., & Ragni, L. (2022). ICT use, digital skills and students' academic performance: Exploring the digital divide. Information, 13(3): 129.

responsibly use and engage with digital technologies for learning, work, and participation in society[258].

This encompasses a range of abilities such as proficiency in computer programs and applications, knowledge of the internet and digital communication tools, the ability to work with digital media and content (e.g. text, images, audio, video), and the ability to analyse and interpret data.

The European Digital Competence Framework (DigComp) has identified the key components of digital competence in five areas: information and data literacy; communication and collaboration; digital content creation; safety; and problem solving[259]. In a nutshell, being digitally competent requires being able to search for information and data and evaluate it; being able to communicate and collaborate in various forms through digital means; being able to create, edit, and improve digital content in a variety of forms (from text to audio content to the ability to create computer programmes); knowing about digital safety and well-being, caring for the environment; being able to solve problems through digital means (from technical to conceptual ones) and to innovate through technologies. DigComp 2.2 (2022) is the fourth version of the European Digital Competence framework. Updates to the previous version incorporated enhancements to the following elements: fact-checking online content and its sources; remote or hybrid work context; digital accessibility; green and sustainability aspects of interacting with digital technologies; well-being and safety; and interaction with AI systems and data literacy.

Although the above definitions from the Council Recommendation and the descriptors from the DigComp framework refer to competences, in the context of this work the term ‘digital skills’ and ‘digital competence’ are used as synonyms. Skills and competences are related but distinct concepts that are often used interchangeably. Skills are the specific abilities or techniques (such the ability to speak a language or to play an instrument). CEDEFOP defines them as the “ability to apply knowledge and use know-how to compete tasks and solve problems.”[260] Competences, on the other hand, are broader attributes or characteristics that describe how an individual performs in a defined context. In the 2006 Recommendation of Key Competences for lifelong learning, competences are defined as a combination of knowledge, skills and attitudes appropriate to the context. Competences are not limited to specific tasks or duties, nor are they limited to cognitive elements or functional ones[261]. Notwithstanding the encompassing nature of the concept of competence, in the frame of this work the term ‘digital skills’ is preferred as it is the most commonly used expression in standard English. It should however be underlined that, within this work, the use of the term ‘skills’ does not refer solely to technical or applied abilities, as digital skills require a specific knowledge and a set of abilities, attitudes and

[258] Council Recommendation of 22 May 2018 on Key Competences for Lifelong learning - 2018/C 189/01.

[259] Joint Research Centre (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. Luxembourg: Publications office of the EU.

[260] Cedefop (2014). Terminology of European education and training policy: a selection of 130 terms. 2nd ed. Luxembourg: Publications Office.

[261] Ibid.

behaviours. Therefore, the choice of the word 'skills' over competence is of a linguistic and pragmatic nature rather than of a conceptual one.

The definition and descriptors that the Commission adopts on digital skills are meant to be overarching and encompassing, thus including a comprehensive understanding of digital skills that would include technical and operational aspects alongside critical thinking and cognitive skills. The domain of digital skills has "low floor, high ceiling"[262], and "wide walls". Seymour Papert postulated that effective technology provides easy ways for novices to get started (low floor) but also ways for them to work on increasingly sophisticated projects over time (high ceiling). This was exemplified in his Logo programming language, where children started by drawing simple shapes and gradually moved on to create more complex geometric patterns.[263] Mitch Resnick adds another dimension: 'wide walls'.[264] He posits that people need a diversity of pathways to engage with personal interests and learn new skills, and the freedom to explore. This metaphor of low floor, high ceiling and wide walls is not only relevant for exploring approaches to programming, but exemplifies the very nature of digital skills, the multitude of applicability and the width of complexity it entails. It comes as no surprise therefore that a plethora of terms is used to describe concepts that have partial or full overlapping with digital skills.

Digital skills and related terms

As academic literature and policy debates originated more than 40 years ago, a multitude of terms has been emerging. The following lines will draw some differentiation between the main concepts that are currently used (namely: ICT skills, media literacy, computational thinking), while underlying that for this line of work the expression 'digital skills' is considered as the most encompassing one.

Definitions of ICT skills (or computer skills) were developed in the 80's and converge in "an understanding of computer characteristics, capabilities and applications, as well as an ability to implement this knowledge in the skilful and productive use of computer applications"[265]. Definitions have survived unaltered for over thirty years[266], and are mainly based on the development of operational and technical skills and knowledge, and a constant reference to the usability of devices (software, hardware)[267]. Nevertheless, the term is still in use with a somewhat wider connotation. For OECD, ICT skills are defined as "using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks"[268]. The reference to the evaluation of information indicates

[262] As formulated by Seymour Papert.

[263] Papert, S. A. (1980). Mindstorms: Children, computers, and powerful ideas. Basic books.

[264] Resnick, M. (2016). Designing for Wide Walls. Design.blog

[265] Simonson, M. R., Maurer, M., Montag-Torardi, M., & Whitaker, M. (1987). Development of a standardized test of computer literacy and a computer anxiety index. Journal of Educational Computing Research, 3(2), 231-247.

[266] Reed, K., Doty, D. H., & May, D. R. (2005). The Impact of Aging on Self-efficacy and Computer Skill Acquisition. Journal of Managerial Issues, 17(2): 212–228.

[267] They are at time referred to 'ICT end-users skills'.

[268] OECD. (2013). OECD Skills Outlook 2013. First Results from the Survey of Adult Skills Organisation for Economic Co-operation and Development. Paris.

a shift towards a slightly different set of competences that are more commonly related to media literacy.

At the end of 2007, the European Commission adopted a communication which defined media literacy as "the ability to access the media, to understand and to critically evaluate different aspects of the media and media contents and to create communications in a variety of contexts"[269]. There is a long academic tradition on studies in media literacy. Media education is typically concerned with a critical evaluation of media, with the analyses of audiences and the construction of media messages, and the understanding of the purpose of these messages.[270] Traditionally stemming from semiotics and social studies, media literacy education has typically stirred away from the more technical, tool-related ICT literacy, leading to a long-lasting tradition of a distinctive split between these two disciplines in university courses and school curricula[271].

The term media literacy was first introduced in the 1980s and has gained increasing importance in recent years with the widespread use of digital media and the upsurge of phenomena as disinformation and fake news. Exposure to large-scale disinformation, including misleading or false information, is a major challenge for citizens[272]. While there are clear regulatory aspects to tackle disinformation[273], media literacy has a very central role to play in supporting citizens (from young people to adults) in their ability to evaluate media messages. For this, the European Commission launched in 2022 a set of guidelines to support teachers and educators in tackling disinformation, where media literacy is defines as "the ability to access the media, to understand and critically evaluate different aspects of the media and media contexts, and to create communications in a variety of contexts." [274] It can be argued that the current upsurge of Artificial Intelligence applications and the generation of deepfake[275] bring to the fore the need (even in a media literacy context) to include an understanding of technical, ICT-related issues, as novel digital technologies make it increasingly difficult to distinguish between real and fake media.[276]

[269] European Commission (2007). A European approach to media literacy in the digital environment. COM(2007) 833 final

[270] Buckingham, David. (2003). Media education: Literacy, learning, and contemporary culture. Cambridge, UK: Polity Press.

[271] Sefton-Green, Julian, Nixon, Helen and Erstad, Ola (2009). Reviewing approaches and perspectives on "digital literacy". Pedagogies: an international journal, 4 (2): 107-125.

[272] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on tackling online disinformation: a European approach. COM(2018)236 final.

[273] Durach, F., Bârgăoanu, A., & Nastasiu, C. (2020). Tackling disinformation: EU regulation of the digital space. Romanian journal of European affairs, 20(1).

[274] European Commission, Directorate-General for Education, Youth, Sport and Culture (2022). Guidelines for teachers and educators on tackling disinformation and promoting digital literacy through education and training. Luxembourg: Publications Office of the European Union.

[275] These are hyper-realistic videos using face swaps that leave little trace of manipulation, which only appeared from 2017 – see Chawla, R. (2019). Deepfakes: How a pervert shook the world. International Journal of Advance Research and Development, 4(6): 4–8.

[276] Westerlund, M. (2019). The emergence of deepfake technology: A review. Technology innovation management review, 9(11).

A term that has emerged in the last decade is computational thinking: shorthand for 'thinking as a computer scientist', the term refers to the ability to understand the underlying notions and mechanisms of digital technologies to formulate and solve problems[277]. Its difference from ICT skills lays in the fact that it is a thought process, thus independent from technology, and requires specific problem-solving abilities. It entails competences in problem-solving, abilities in examining data patterns and questioning evidence[278]; collecting, analysing and representing data, decomposing problems[279]; abstraction and debugging[280] . As noted in a 2022 JRC report, the relevance of computational thinking stems from the fact that there is an overwhelming majority of member states that are considering inserting (or have already inserted) aspects and concepts of computational thinking in their curricula.[281] Computational thinking is strongly connected to Informatics / Computer Science. Unlike ICT skills, the emphasis is on the cognitive aspects rather than the operational ones.

Levels of digital skills

As stated above, digital skills have low floor, high ceiling and wide walls. This is reflected in a diversity of proficiency levels and degrees of complexity. Levels of digital skills can be considered as a spectrum: from basic skills, which are related to low, operational abilities to make use of digital devices and understand issues related to the digital and online world, to the higher spectrum, which sees higher-level abilities that allow individuals to make use of digital technologies in empowering and transformative ways, such as professions in ICT[282].

In Eurostat, an example of an indicator for measuring digital skills is the Digital Skills Indicator 2.0[283], a proxy for digital skills developed to measure them against the five competence areas of DigComp (information and data literacy skills, communication and collaboration skills, digital content creation skills, safety skills and problem-solving skills). To have at least basic overall digital skills, people must know how to do at least one activity related to each area. It shall be noted however that it is assumed that individuals having performed certain activities have the corresponding skills. Therefore, the indicators can be considered as proxy of individuals' digital skills.[284] For this indicator, in other terms, activity in a certain area is equal to proficiency.

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[277] European Commission (2016). Developing computational thinking in compulsory education. JRC Science for Policy Report.

[278] Charlton, P., & Luckin, R. (2012). Time to re-load? Computational Thinking and Computer Science in Schools (Briefing 2, 27 April). The London Knowledge Lab.

[279] Gretter, S., & Yadav, A. (2016). Computational Thinking and Media & Information Literacy: An Integrated Approach to Teaching Twenty-First Century Skills. TechTrends, 1–7.

[280] Csizmadia, A., Curzon, P., Dorling, M., Humphreys, S., Ng, T., Selby, C., & Woollard, J. (2015). Computational thinking A guide for teachers. Computing at School.

[281] Bocconi, S., Chioccariello, A., Kampylis, P., Dagienė, V., Wastiau, P., Engelhardt, K., Earp, J., Horvath, M.A., Jasutė, E., Malagoli, C., Masiulionytė-Dagienė, V. and Stupurienė, G., Reviewing Computational Thinking in Compulsory Education, Inamorato Dos Santos, A., Cachia, R., Giannoutsou, N. and Punie, Y. editor(s), Luxembourg: Publications Office of the European Union

[282] UNESCO (2018) Digital skills critical for jobs and social inclusion.

[283] Vuorikari, R., Jerzak, N., Karpinski, Z., Pokropek, A. and Tudek, J., (2022). Measuring Digital Skills across the EU: Digital Skills Indicator 2.0, JRC Technical Report, Luxembourg: Publications Office of the European Union.

[284] Eurostat (2021): Database – Digital Economy and Society – Eurostat (europa.eu): Individuals' level of digital skills [ISOC_SK_DSKL_I21]

Moving beyond basic levels of digital skills, the scenarios get even more complex and articulated. The International Telecommunications Union (ITU) defines three main proficiency levels: basic (foundation for use of digital means); intermediate (use of digital technology in meaningful and beneficial ways); and advanced (for ICT specialists).[285] DigComp provides eight proficiency levels defined through learning outcomes, each level represents a step up in citizens' acquisition of the competence according to its cognitive challenge, the complexity of the tasks they can handle and their autonomy in completing the task[286]. Although the above differentiations are useful, the applicability of digital skills to different domain of life, citizenship, learning and leisure gives way to a variety of needs, and this complexity is hardly grasped through the above categories. New advanced and highly specialist digital skills are emerging[287] that over-simplify the category of ICT professional – as professionalism in the digital domain already covers a multitude of aspects (AI, Cybersecurity, programming, data analysis to name a few). In addition, the emergence of new types of digital skills is rendered even more complex by the lack of a common understanding of what these skills are. For example, the lack of cybersecurity skills that exists in the labour market, is partly driven by the fact that different actors in the sector have a different understanding of the competences and skills at play[288].

Moreover, there is a widening number of highly skilled people that, without being categorised as ICT-professionals, have advanced or highly specialised digital skills that cover a very specific or a relatively wide domain. For instance, professionals in social media hold advanced competences in purposeful digital communications, medical doctors that use complex visualisation and data analysis tools are also extremely skilled in digital but are not part of the ICT sector. The width and breadth of digital skills makes it challenging (albeit not impossible) to design certification schemes and qualifications that aim at grasping an overarching concept of digital skills. DigComp 2.0 includes digital skills for work, suggesting 8 proficiency levels covering from Basic/Foundation, intermediate, advanced up to highly specialised levels. These could cover the need of education and training content, assessment and certification services for individual competences at expert level. For non-ICT specialists, dedicated content and certification could also be developed.

2. Existing digital skills gaps

In the world of tomorrow, we must rely on digitally empowered citizens, a digitally skilled workforce and digital experts. Individual digital skills across Europe are insufficient to meet the needs of the economy and the society, as suggested by aggregate statistics from both the

[285] International Telecommunications Union (2020). Digital Skills Assessment Guidebook.

[286] 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, Luxembourg: Publications Office of the European Union.

[287] International Telecommunications Union (2019). Digital Skills Insight.

[288] ENISA (2022), European Cybersecurity Skills Framework (ECSF) - User Manual.

supply side (measured as individual digital skills) and the demand side (measured as the level of skills required by the labour market)[289].

Access to the internet and use of digital tools is no longer a novelty. They have become essential for citizens, companies, organisations, and governments. The COVID-19 crisis and the need to ensure fast and effective recovery accelerated this trend and contributed in raising awareness on the **importance of investing in digital skills at all levels**, be it for young people, adults or professionals. Moreover, data show[290] a mismatch between the digital competences required at work and those possessed by the EU workforce, which challenges EU innovation and competitiveness.

The increasing pervasiveness of digital tools in our society requires policies to support citizens, workers and businesses. To this purpose, **European legislation set specific targets** for re- and up-skilling European citizens at different age levels. Europe's Digital Decade goals in the skill area are that, by 2030, 80% of citizens should possess at least basic digital skills and at least 20 million ICT specialists are employed in the EU[291]. Further 2030 goals[292] in the education area aim at reducing the level of low-achieving eight-graders in digital skills below 15%.

Table 1: Status quo vs targets

	Status quo[293]	**2030 target**
Share of low-achieving eight-graders in digital literacy	34%*[294]	Below 15%
Share of adults with at least basic digital skills	54%[295]	80%
Employed ICT specialists	9 million, 81% male[296]	20 million, better gender balance

** Please notice that this number cannot be considered a meaningful EU average as it refers to the average share of low achievers in the six countries that participated in ICILS 2018*[297].

[289] See following references for examples.

[290] Cedefop (2018). Insights into skill shortages and skill mismatch: learning from Cedefop's European skills and jobs survey. Luxembourg: Publications Office of the European Union.

[291] Decision establishing the Digital Decade Policy Programme 2030, PE/50/2022/REV/1 (2022),

[292] Council Resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021-2030), 2021/C 66/01 (2021),

[293] All data, With the exception of the first value (marked by *), refer to 2021.

[294] Fraillon J., Ainley J., Schulz W., Friedman T., Duckworth D. (2019). Preparing for Life in a Digital World: International Computer and Information Literacy Study 2018 International Report. Amsterdam: IEA.

[295] EU-27. Eurostat (2021): Database – Digital Economy and Society – Eurostat (europa.eu): Survey on the use of ICT in households and by individuals [ISOC_I].

[296] EU-27. Eurostat (2021): Microdata – Eurostat (europa.eu): European Union Labour Force Survey [EU_LFS].

[297] Seven EU countries participated in ICILS 2018 but Italian data are excluded from the average, as testing in Italy took place at the beginning at the school year and data is not comparable to that of the other countries. The next ICILS data collection

Reaching these targets will require continuous effort and targeted measures. A recent simulation by Codagnone et al. (2021) reveals that by the end of this decade, Europe will not be able to reach the Digital Decade target on basic digital skills if no drastic measures and investments on the supply side are taken: the current trajectory reveals that by 2030, only 64% of the population will possess at least basic digital skills.[298]

As for the second Digital Decade target, the simulation by Codagnone et al. (2021) shows that, following the current trajectory, only 13.3 million ICT specialists will be employed by 2030 (6.7 million below the envisaged target) if no further steps are taken.

The following section gives an overview of the level of digital skills for different groups of the population and across Member States, over the entire skill spectrum: from basic to advanced and specialist digital skills.

2.1 Level of digital competence across the EU

Digital skills are increasingly becoming a **differentiating factor** with high impact on people empowerment, social inclusion and employability. Rapid and widespread digitalisation has changed Europe's society and increased the demand for digital skills and competences at all levels and in all sectors of the economy. The Covid-19 pandemic outbreak prompted an acceleration of the process, forcing people of all ages and backgrounds to quickly learn new competencies, in particular related to digital technologies. While the disruption enabled some to quickly acquire new skills, it has also exacerbated already existing digital skills gaps[299].

Results from the public consultation run in preparation of the Digital Education Action Plan 2021-2027[300] confirmed the growing importance that citizens give to digital competences. It showed that the use of technologies done during the initial stages of the pandemic led to a perceived increased level of digital skills and revealed individuals' willingness to further improve them in the future.

However an analysis of the available data shows that the **level of digital skills of different segments of the population remains low**.

In 2021, **only 54% of the population in the EU had at least basic digital skills**[301] (Figure 7). Change over time has been limited. Between 2015 and 2019 (first and last year with available

will take place in 2023, 22 Member States are planning to participate in the core module, and 17 in the optional computational thinking module.

[298] Codagnone, C., Liva, G., Gunderson, L., Misuraca, G., Rebesco, E., (2021). Europe's Digital Decade and Autonomy, Publication for the committee on Industry, Research and Energy, Policy Department for Economic, Scientific and Quality of Life Policies. Luxembourg: European Parliament

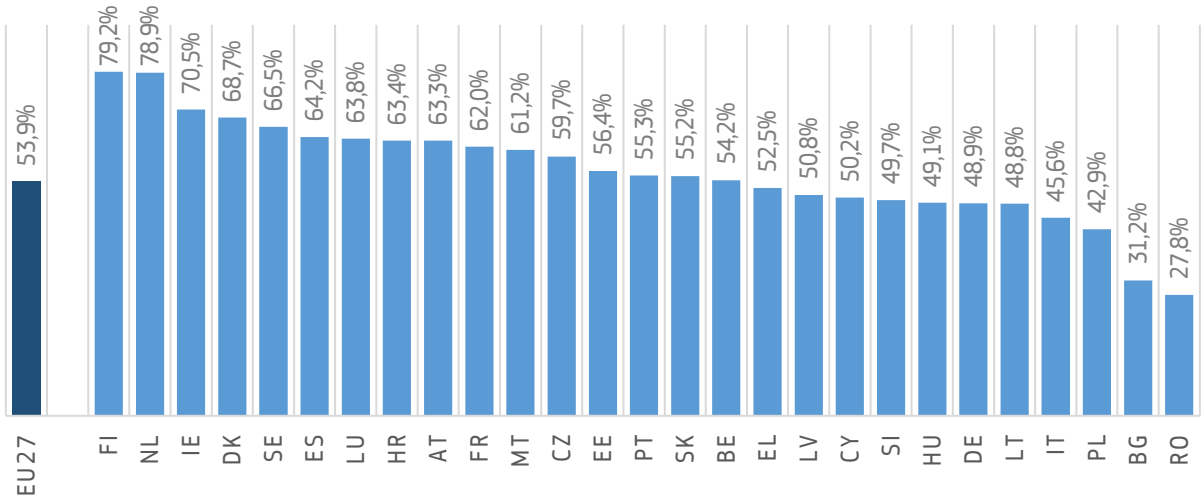
[299] Di Pietro, G., Biagi, F., Dinis Mota Da Costa, P., Karpinski, Z. and Mazza, J. (2020). The likely impact of COVID-19 on education: Reflections based on the existing literature and recent international datasets, EUR 30275 EN. Luxembourg: Publications Office of the European Union

[300] Open Public Consultation of the Digital Education Action Plan 2021-2027. See Annex 2 for further details.

[301] EU-27 value. Eurostat data on individual's level of digital skills from 2021 on are based on new methodology and thereby are not directly comparable to the ones collected in 2019 and before. In particular, the Digital Skills Indicator 2.0 (DSI) is a composite indicator based on selected activities related to internet or software use that individuals aged 16-74 perform

comparable data) the share of adults with basic digital skills increased by only 2 percentage points[302].

Figure 7: At least basic skills (% of 16-74-year-old individuals) - Eurostat 2021



Source: Eurostat

Figure 7 shows that major disparities still exist between Member States: the share of people aged 16 to 74 who had at least basic digital skills is highest in the Netherlands and Finland (both approx. 79%) and lowest in Romania (27.8%). Differences related to gender, level of education, and socio-economic backgrounds persist. In addition there is a 15 percentage point gap between rural residents (46%) and city residents (61%) that remained stable over the period 2014-2019[303] (Figure 8).

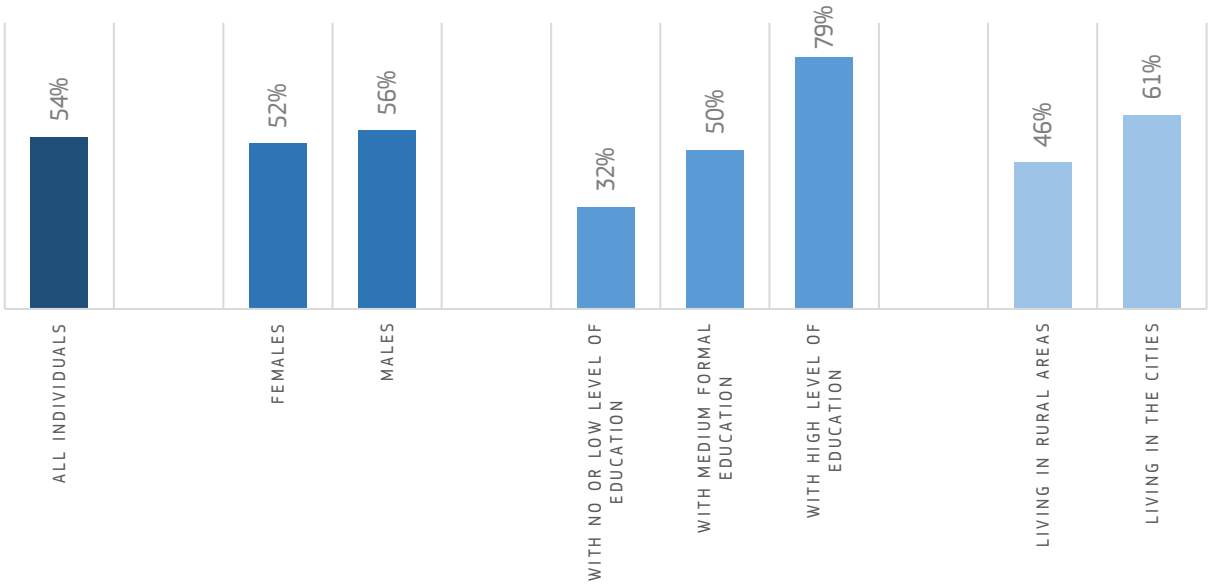
By 2022, the share of EU households with internet access had risen to 93% and the number of people in the EU not using the internet fell in almost all countries between 2015 and 2022 (7% in 2022). 89% of individuals were regular internet users (using it at least weekly), while almost 84% were using it either every day or almost every day. However having an internet connection and using the internet is not sufficient and evidence clearly shows that it must be paired with the appropriate skills to take advantage of the opportunities of the digital society.

in five specific areas (Information and data literacy, Communication and collaboration, Digital content creation, Safety, and Problem solving). The area of Safety was added in 2021 to reflect the five competence areas of the revised Digital Competence Framework and better align the indicator to the needs of today's digital economy and society.

[302] A change in survey methodology prevents comparisons between 2021 and previous editions of the survey. EU-27 value: 54% in 2015 and 56% in 2019. Eurostat (2021): Database – Digital Economy and Society – Eurostat (europa.eu): Survey on the use of ICT in households and by individuals [ISOC_I].

[303] Staff working document accompanying the long-term vision for the EU's rural areas - COM(2021)166 Final

Figure 8: At least basic skills (% of 16-74-year-old individuals) by gender, level of education and living area (EU27 values)



Source: *Eurostat*

On average, the **level of digital skills among the labour force** is higher than that of the population. However, more than a third of the labour force in the EU, including employed people and the unemployed, are lacking basic digital skills, even though 87% of jobs in the EU+ now require them[304] . Following the Covid-19 outbreak, 60-70% of EU+ workers use standard software at work (web browsing, emailing, word processing, spreadsheets) requiring basic or moderate digital skills. Half of EU+ workers use specialised software and about 1 in 10 require very high digital procificency. Research[305] show that even in sectors not traditionally related to digitisation (e.g. farming, health care, construction, etc.) and for more traditional professions, such as medical doctors or lawyers, there is a significant increase in the demand for sectoral knowledge combined with digital skills enabling the use of digital solutions for specific business cases. To name two examples, medical doctors are increasingly relying on advanced digital technologies such as artificial intelligence for providing more accurate diagnoses or process data of their patients in electronic health records whereas farmers are more and more using advanced data analysis to optimise their production processes.

Small and medium-sized enterprises (SMEs) are particularly experiencing an increased competition for digitally skilled talent as they compete with larger companies on an already tense job market. The Structured Dialogue on Digital Education and Skills revealed that upskilling and reskilling of SME employees is therefore of high priority for a large majority of Member States. However, 2022 data by Eurostat shows that only 20.9% of SMEs provided training to all their staff in order to enhance their ICT related skills, compared to 69.5% of large

[304] Cedefop (2022). Challenging digital myths, first findings from Cedefop's second European skills and jobs survey.

[305] European Commission (2017). ICT for work: Digital skills in the workplace.

companies (i.e. a ratio three times lower)[306]. In this respect, a recent report[307] demonstrated that the greatest barrier to providing digital skills training to SME employees is a lack of time: whereas SME managers are not inclined in having their staff undergo training during working hours as they fear a loss in productivity, staff, in turn, are less willing to get a training outside their working hours. Additional barriers concern the availability of training opportunities, cost, inflexible timetables and distance.

Outcomes of the Structured Dialogue show common concerns about the mismatch that exists between the supply and demand of digital skills. The last Cedefop European skills and jobs survey[308] show that 46% of the adult population in the EU lacks even basic digital skills[309]. This means that many workers use ICT every day at work without having the skills to do so effectively[310], an element long considered to have a negative effect on workplace performance[311]. This is supported by a recent publication examining which workers were best positioned to work from home during the COVID-19 lockdown. The study shows that the likelihood of working from home decreases for workers without tertiary education and with lower levels of skills. These findings raise important questions on the extent to which the pandemic exacerbated existing labour market inequalities and whether these inequalities could worsen with intensified adoption of technology[312]. They also call for renewed and focused action to develop the digital skills of the workforce through, for instance, initiatives boosting the level of adults digital competences and acknowledging the role of employers and the private sector in promoting and providing specific training and on-the-job-learning of digital skills[313].

The **level of digital skills level of European students** (i.e. individuals above 16 whose employment status is 'student') is higher compared to that of the overall population and labour force with 77% of them in 2021 having basic or above basic digital skills.[314]

[306] Eurostat (2022): Database - Digital economy and society - Eurostat (europa.eu): Enterprises that provided training to develop/upgrade ICT skills of their personnel by size class of enterprise [ISOC_SKE_ITTS]

[307] European Commission (2019): Digital Skills: New Professions, New Educational Methods, New Jobs. Retrieved from https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=60738

[308] Cedefop (2022). Setting Europe on course for a human digital transition: new evidence from Cedefop's second European skills and jobs survey. Luxembourg: Publications Office of the European Union.

[309] "Eurostat (2022): News Article - Eurostat (europa.eu): How many citizens had basic digital skills in 2021?" reports similar numbers. However, only individuals who have used the internet 3 months prior to the survey were asked about their activities. An 11% of individuals, included in the measured 46%, didn't access internet in the last 3 months and therefore their digital skills could not be assessed.

[310] OECD (2016). Skills for a Digital World. Policy Brief on the Future of Work.

[311] European Commission (2017). ICT for Work: Digital Skills in the Workplace.

[312] Espinoza R., Reznikova L. (2020). Who can log in? The importance of skills for the feasibility of teleworking arrangements across OECD countries. OECD Social, Employment and Migration Working Papers, No. 242, Paris: OECD Publishing.

[313] European Skills Agenda for sustainable competitiveness, social fairness and resilience. COM(2020)441 final/2.

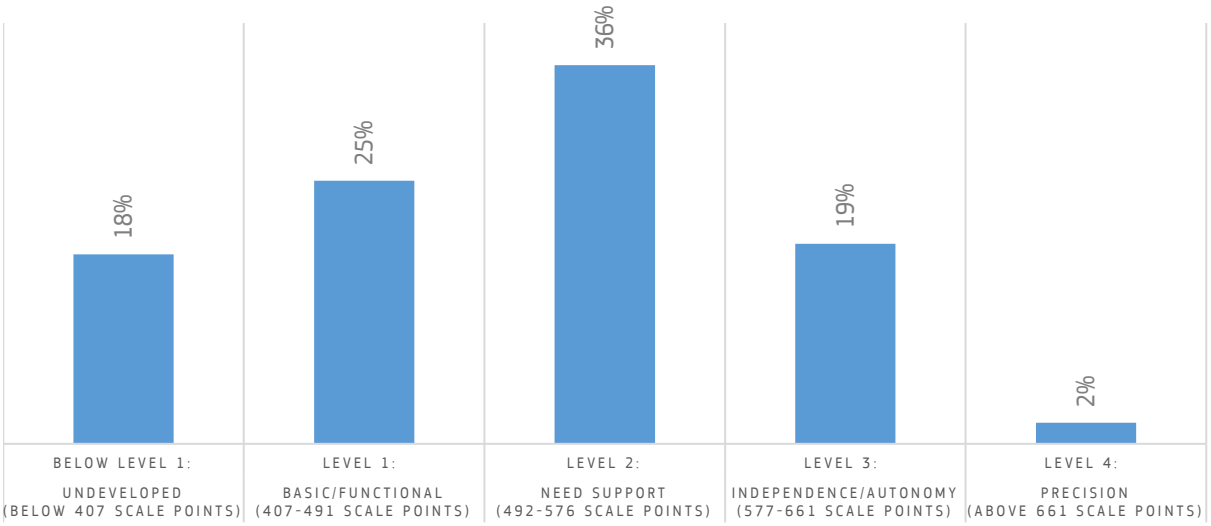
[314] Fraillon, J. Ainley, J., Schulz, W., Friedman, T., Duckworth, D. (2019). Preparing for Life in a Digital World: International Computer and Information Literacy Study 2018 International Report. Amsterdam: IEA.

However, in 9 out of 14 Member States[315] that participated in the two rounds of the International Computer and Information Literacy Study (ICILS)[316], more than one third of pupils did not possess the most basic proficiency level[317] in digital skills[318].

ICILS showed that despite the growing awareness on the need to equip young people with the digital skills necessary to be empowered and safe online (e.g. digital literacy), in 2018 only 53% of the 15-year-olds in the EU reported being taught how to detect whether information is subjective or biased. Moreover, a 2019 Eurobarometer poll[319] reported that 41% of young Europeans judged that critical thinking and media were not taught sufficiently in schools.

Figure 9 shows that, in 2018, the majority of students in most countries scored at or below level 2 (e.g. need support), a result clearly highlighting the need to support young people developing digital skills when using digital devices.

Figure 9: Distribution of students' scores on the computer and information literacy scale



Source: ICILS 2018

[315] ICILS 2018: DK, DE, FR, IT, LU, PT, FI. ICILS 2013: CZ, DK, DE, HR, LT, NL, PL, SI, SK.

[316] The International Computer and Information Literacy Study (ICILS) is a performance test measuring international differences in computer and information literacy and computational thinking of students in their eighth year of schooling.

[317] Students' scores on computer and information literacy - defined as individual's ability to use computers to investigate, create and communicate in order to participate effectively at home, at school, in the workplace, and in society - were divided in four levels of increased sophistication in the use of digital technologies.

[318] Fraillon, J. Ainley, J., Schulz, W., Friedman, T., Duckworth, D. (2019). Preparing for Life in a Digital World: International Computer and Information Literacy Study 2018 International Report. Amsterdam: IEA.

[319] Standard Eurobarometer 92 - Autumn 2019

At a young age, girls outperform boys in computer and information literacy[320] and in Science, Technology, Engineering and Mathematics (STEM)[321], and tend to use digital tools for school activities more than boys.[322]. According to the OECD's Programme for International Student Assessment (PISA), boys and girls are equally likely expected to work in a science-related field[323]. However with age and at higher levels of education, girls tend to steer away from some STEM[324] and ICT subjects and this is reflected in their lower participation in related higher education studies and professions in the labour market. Despite large differences between countries[325], in 2020 women represented only 18% of students enrolled in ICT studies and one in five ICT specialists[326]. Geographical and socioeconomic background, including migrant status and language spoken at home, are identified as having a statistically significant effect on students' achievement[327].

2.2 ICT specialists and emerging skills needs

Europe also faces a shortage of digital experts who can develop cutting-edge technologies and the sector has a strong gender imbalance. ICT specialists, people who deal with developing, operating and maintaining information technology systems, are employed across all sectors of the economy, with a different percentage depending on the size of the organisation[328]. The majority of Member States expressed concerns about the significant shortage in ICT specialists in the Structured Dialogue on Digital Education and Skills, confirming the need to do further work to attract a larger and more diversified talent pool into the digital sector. A CEDEFOP study in 2019[329] reported that 53% of EU companies had difficulties filling vacancies for ICT

[320] Fraillon, J. Ainley, J., Schulz, W., Friedman, T., Duckworth, D. (2019). Preparing for Life in a Digital World: International Computer and Information Literacy Study 2018 International Report. Amsterdam: IEA.

[321] OECD (2019). Why don't more girls choose to pursue a science career? PISA in Focus, n° 93.

[322] Smahel D., Machackova H., Mascheroni G., Dedkova L., Staksrud E., Ólafsson K., Livingstone S., Hasebrink U. (2020). EU Kids Online 2020: Survey results from 19 countries. EU Kids Online.

[323] OECD (2017). What kind of careers in science do 15-year-old boys and girls expect for themselves? PISA in focus. Paris: OECD publishing.

[324] Data suggest that gender disparity in STEM graduates has shrunk in 2020 compared to previous years. Certain scientific fields, like biological sciences, show a higher percentage of female graduates compared to males. (source: Eurostat (2020): Statistic explained - Eurostat (europa.eu): - Tertiary education statistics)

[325] For instance in Eastern Europe women occupy nearly half of the high-tech jobs. In 2020 in Czechia, Hungary and Malta, almost every 9 out of 10 ICT specialists were men, while in Bulgaria almost every third ICT specialist was a woman.

[326] The percentage of women in ICT careers still remains below 2% of women's total share in the European labour market See European Parliament (2020). Education and employment of women in science, technology and the digital economy, including AI and its influence on gender equality. Luxembourg: Publication office of the European Union.

[327] Karpiński Z., Di Pietro G., Biagi F. (2021), Computational thinking, socioeconomic gaps and policy implications, Compass Briefs in Education, n.12, January 2021, Amsterdam: IEA.

[328] In 2022 the percentage of large enterprises employing ICT specialists (77,6%) was more than 5 times higher than that for small sized enterprises (15,1%). Eurostat (2022): Database - Digital economy and society - Eurostat (europa.eu): Enterprises that provided training to develop/upgrade ICT skills of their personnel by size class of enterprise [ISOC_SKE_ITSPE]

[329] Cedefop (2019). The changing nature of work and skills in the digital age, Luxembourg: Publications Office of the European Union.

specialists. Consistently, Eurostat reports that 62.8% of enterprises with at least 10 employees, which tried to recruit ICT specialists, had hard-to-fill vacancies in 2022[330].

ICT knowledge and advanced digital skills are mostly requested from ICT professionals and ICT technicians, followed by research, engineering and clerical occupations. The demand for ICT specialists is specifically striking in key industrial ecosystems such as automotive, aerospace, electronics as well as in critical technologies for all sectors such as data, cybersecurity and semiconductors. In cybersecurity, to name one example, the shortage of professionals in Europe ranges between 260,000[331] and 500,000[332], while studies estimate the Union's needs at 883,000 professionals[333]. According to such data, at best, the European Union requires a 29% rise in its cybersecurity workforce to close the gap on the job market. This skills gap hampers the EU's capacity to develop cutting-edge technologies such as AI and 5G, and to defend our critical infrastructure. In addition, the increasingly complex cybersecurity threat landscape combined with an evolving policy environment that places new forms of obligations on Member States and businesses, make the lack of an adequately skilled cybersecurity workforce a risk to securing the resilience of the European Union. However, and even more so following the COVID-19 pandemic, digital skills demand in many occupations, especially non-ICT ones, is on the rise[334].

Sweden had the highest relative share of ICT specialists in the total work force, with 407,100 persons employed as ICT specialists followed by Finland with 188,000 ICT specialists. Relatively high shares of employed ICT specialists were also recorded in Luxembourg, the Netherlands, Ireland, Estonia, Belgium and Denmark, with each reporting at least 1 in 20 persons within their workforce employed as an ICT specialist. By contrast, at the other end of the range, ICT specialists accounted for 2.6 % of the total workforce in Romania and by 2.4 % in Greece (Figure 10)[335].

[330] Eurostat (2022): Database - Digital economy and society - Eurostat (europa.eu): Enterprises that recruited or tried to recruit ICT specialists by size class of enterprise [ISOC_SKE_ITRCRS]

[331] (ISC²) (2023): (ISC²) in Assessing Cyber Skills on the basis of the ECSF, ENISA webinar (Youtube), 16 February 2023

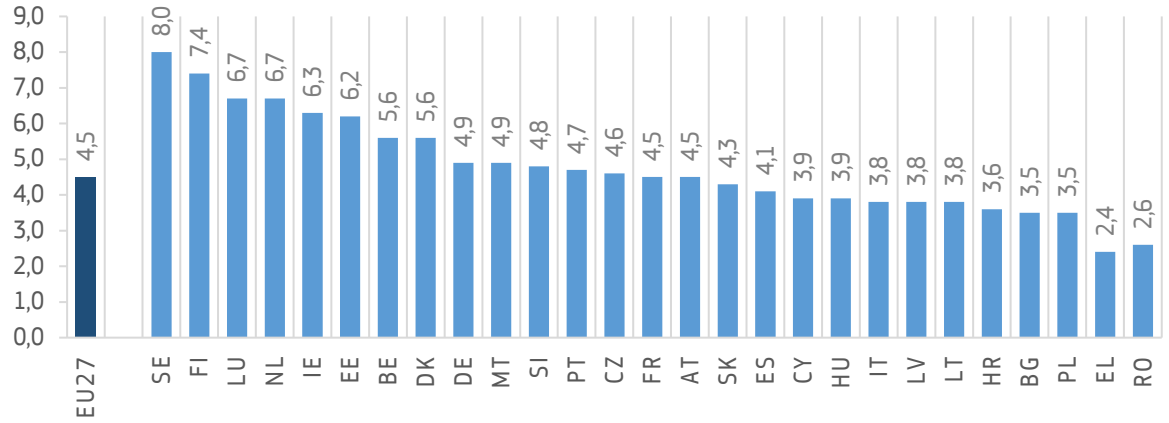
[332] Joint Communication to the European Parliament and the Council, EU Policy on Cyber Defence, JOIN(2022) 49 final

[333] (ISC²) (2023): (ISC²) in Assessing Cyber Skills on the basis of the ECSF, ENISA webinar (Youtube), 16 February 2023

[334] Cedefop (2021), Digital skills: challenges and opportunities during the pandemic.

[335] Eurostat (2021): Database - Digital economy and society - Eurostat (europa.eu): Employed ICT specialists - total [ISOC_SKS_ITSPT]

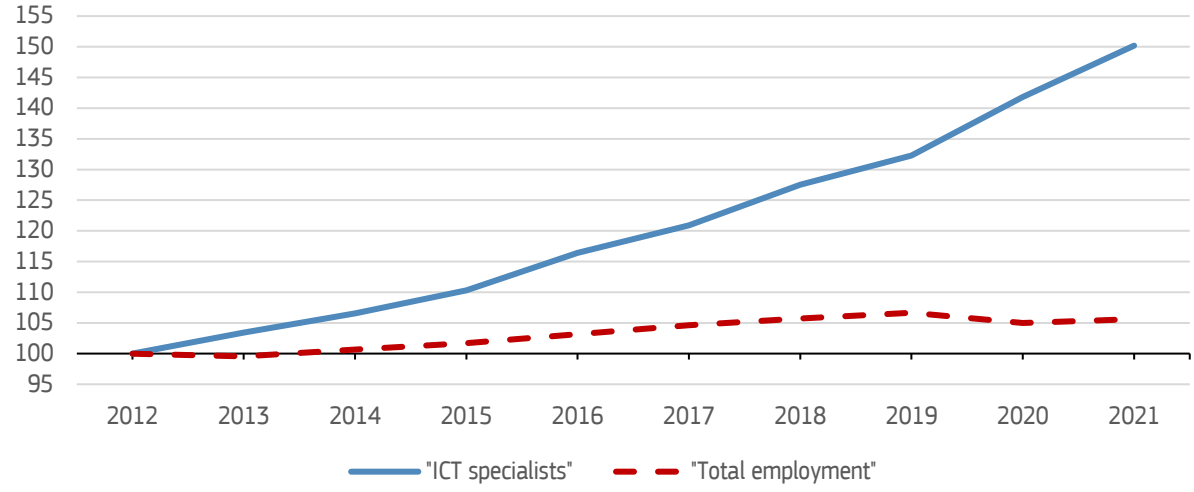
Figure 10: ICT specialists (% of work force)



Source: Eurostat 2021

Over the last decade, ICT specialists in employment rose with an average annual growth rate of 4.6% (Figure 11). After a regular but slow increase between 2012 and 2019, the number of ICT specialists presented its highest progression rate between 2019 and 2020 (7.3%) and between 2020 and 2021 (6.1%)[336].

Figure 11: Index of the number of persons employed as ICT specialists and total employment in the EU 2012-2021



Source: Eurostat 2021

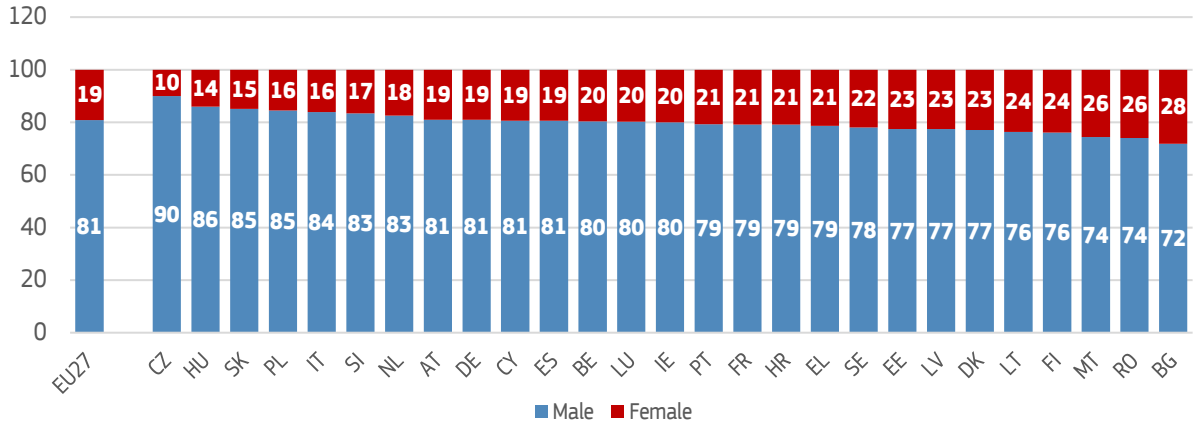
The vast majority of ICT specialists in the EU are men (81%) confirming a trend that has been there for a decade[337]. Women's underrepresentation occurs at all levels of the digital economy and has multifaceted roots. In cybersecurity, for example, women represent only 20% of

[336] Eurostat (2022): Statistic explained - Eurostat (europa.eu): ICT specialists in employment.

[337] The share of ICT employment that was accounted for by men stood at 81% in 2021, which was 2 percentage points lower than it had been in 2012.

cybersecurity graduates[338]. Key challenges for girls and women in the digital age are their visibility and a lack of valued role models, reinforced by their underrepresentation in ICT-related studies, gender bias and stereotypes, and a low participation of women in digital entrepreneurship and innovation. Structural barriers, such as working conditions and culture hinder girls and women to enter the predominantly male ICT-field[339].

Figure 12: Distribution of ICT specialists by sex



Source: Eurostat 2021

In 2021 about 9 out of 10 ICT specialists in Czechia, Hungary and Slovakia and Poland were men. While men accounted for about 8 out of 10 ICT specialists in the majority of the remaining EU Member States, Malta, Romania and Bulgaria were the only Member States where the share of men was lower than 75% (Figure 12).

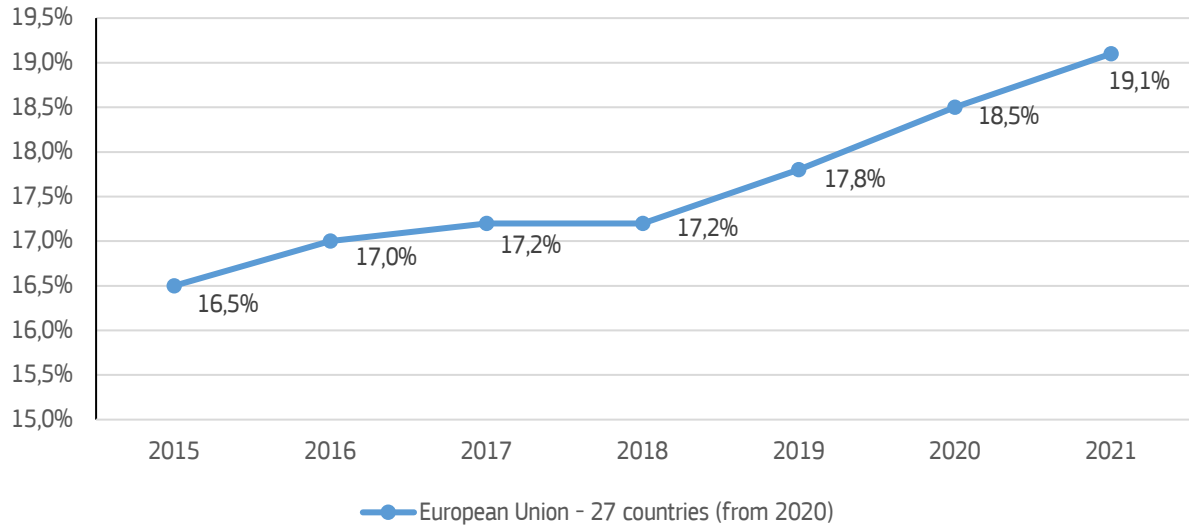
A closer analysis of the gender gap reveals that the share of female ICT specialists is slowly increasing (Figure 13). Since 2012, the most striking progressions were observed in Malta where the share of women in the total number of ICT specialists rose 15.2 percentage points, followed by Luxembourg and Portugal, up 9.3 and 6.5 percentage points respectively. By contrast, the relative share of men in the total number of ICT specialists rose the most in Greece, Bulgaria and Estonia, up by 4.1, 3.9 and 3.6 percentage points respectively[340].

[338] ENISA (2022), Cybersecurity Higher Education Database (CyberHEAD)

[339] Women in Digital Declaration, .

[340] Eurostat (2022) : Statistic explained - Eurostat (europa.eu): ICT specialists in employment.

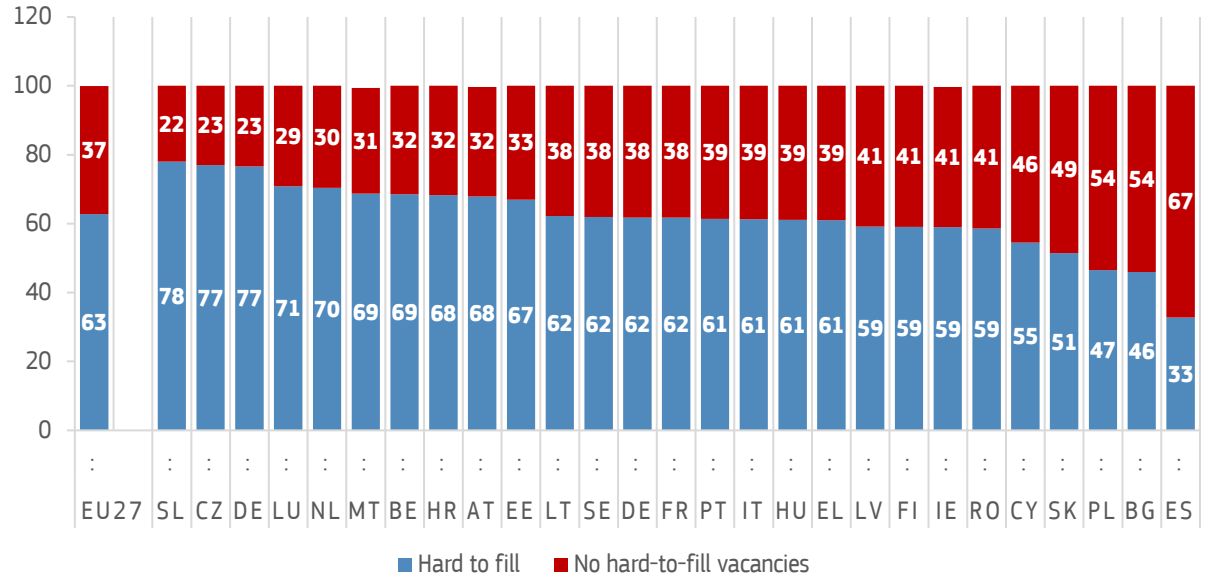
Figure 13: Women ICT specialists



Source: Eurostat 2015-2021

As already mentioned, despite the overall trend in the growth of employed ICT specialists, most enterprises keep reporting difficulties in filling the growing number of vacancies for ICT specialists[341,342]. There are also major differences between countries: they range from 78.0% in Slovenia to 32.8% in Spain (Figure 14).

Figure 14: Enterprises that recruited ICT specialists, with or without difficulties



Source: Eurostat 2021

[341] Cedefop (2019). The changing nature of work and skills in the digital age, Luxembourg: Publications Office of the European Union.

[342] Eurostat (2022): Database - Digital economy and society - Eurostat (europa.eu): Enterprises that recruited or tried to recruit ICT specialists by size class of enterprise [ISOC_SKE_ITRCRS]

The trends observed regarding the increase of ICT specialists employed and the difficulty that companies keep having in recruiting these profiles is a clear sign of the ongoing digital transformation affecting the whole economy.

In 2021 sliglthly less than two thirds (64.5%) of employed ICT specialists in the EU had a tertiary level of education, which shows the importance of increasing the number of ICT graduates from upper-secondary and higher education[343] - especially considering that in these disciplines entry requirements and dropout rates are high, and female participation is low.

On the supply side, approximately 4.2 million students graduated from tertiary education in the EU in 2020. ICT makes up less than 5% of the total number of enrolled students and graduates (respectively 4.9% and 3.9%)[344], even though it is most commonly associated with technological progress and high employability[345]. The low number of ICT graduates and the growing number of ICT vacancies[346] suggest that the gap between the demand and supply of ICT specialists may be widening. In vocational education and training, the field 'information and communication technologies' had nearly 495 000 students enrolled in upper secondary education in 2020[347], and nearly 49 000 in post-secondary non-tertiary education[348] [Note: 885k enrolled in tertiary in the same field, of whom 91k in short cycle tertiary VET[349]].

To lead digital transformation, Europe needs excellent higher education institutions, which can attract and retain students in ICT and related fields by offering high quality education, including in forward-looking ICT-related fields. Equally companies need to invest more in education and training and consider it a strategic action to equip or enhance employees' digital skills. However, in 2021, only 22.4% of enterprises provided ICT training for their staff [350] (up 3.3 percentage points from 2012) and this happened in 69.5% of the cases among large enterprises and only in 20.9% of cases among small and medium enterprises[351]. Despite a slow upward trend in training investments observed in recent years, supported by labour market recovery,

[343] The share of ICT specialists in employment with a tertiary level of educational attainment rose by 9.4 percentage points between 2012 and 2021.

[344] For other STEM fields, engineering, manufacturing and construction-related studies makes up 114.8% of the total number of graduates and 15.8% of enrolled students; while natural science, mathematics and statistics 6,2% of graduates and 6.8% of enrolled students.

[345] Eurostat (2020): Statistic explained - Eurostat (europa.eu): Tertiary education statistics.

[346] For instance in the EU in 2017 there were approximately 496,000 unfilled positions in the area of big data and analytics. Communication from the Commission a European strategy for data. COM/2020/66 final.

[347] Eurostat (2020) : Database – Population and social conditions - Eurostat (europa.eu): Pupils enrolled in upper-secondary education by programme orientation, sex and age [EDUC_UOE_ENRS05]

[348] Eurostat (2020): Database – Population and social conditions - Eurostat (europa.eu): Pupils enrolled in post-secondary non-tertiary education by programme orientation, sex, type of institution and intensity of participation [EDUC_UOE_ENRS07]

[349] Eurostat (2020) : Database – Population and social conditions - Eurostat (europa.eu): Students enrolled in tertiary education by education level, programme orientation, sex and field of education [EDUC_UOE_ENRT03]

[350] The percentage of companies investing in on-the-job training for their ICT professionals goes down to 10%.

[351] Eurostat (2021): Database - Digital economy and society - Eurostat (europa.eu):Enterprises that provided training to develop/upgrade ICT skills of their personnel by size class of enterprise [ISOC_SKE_ITTS]

differences across enterprises and countries persist[352]. In the consultations organised in preparation of this initiative, representatives of the private sector highlighted the importance of valuing, recognising and fostering investments in upskilling and reskilling employees[353].

Being at the forefront of the technological revolution is crucial to ensure competitiveness and shape the conditions for its development and use. Having ICT specialists and a digitally competent workforce is a crucial element for an inclusive and competitive digital economy and society. Several actions at both EU and Member States' level aim to tackle the digital skills mismatch, but, as highlighted by consulted stakeholders[354], additional support is needed to target specific learning needs and specific priority groups[355].

2.3 Further challenges to address

Targeted investments and comprehensive reforms are needed to close the digital skills gap, achieve the EU targets on digital skills, and make sure that people of all ages and backgrounds can really seize the opportunities offered by the digital transformation. However any action on competence development requires a **thorough and recognised assessment of the individual level of digital competence**. Defining the starting point and understanding the related learning needs is crucial to identify what learning opportunities can be offered to specific target groups both during their educational journey and in a lifelong learning perspective.

As described in section 2.1, there are still large **differences between Member States** regarding the level of digital skills of different segments of the population and the starting point varies largely from country to country. For instance the Digital Economy and Society Index (DESI)[356] shows that the level of convergence between Member States is increasing but the gap between the EU's frontrunners and those with the lowest scores is still large. In terms of improvements, most Member States have made good progress in the last five years, however, efforts are still needed almost everywhere to meet the Digital Decade targets[357].

There is also **variation within countries** connected to the high impact that individuals' socio-economic backgrounds and level of education have on the level of digital skills. The gap

[352] Pouliakas K., Wruuck I.P. (2022). Corporate training and skill gaps. Did Covid-19 stem EU convergence in training investments? European Investment Bank – Working papers 2022/07.

[353] See Annex 2 for further details.

[354]Closing the gender digital skills gap was widely supported during exchanges with Member States and Members of the European Parliament and seen as a priority area of focus by a quarter of consulted groups. See Annex 2 for further details.

[355] Cedefop (2020). Empowering adults through upskilling and reskilling pathways. Volume 1: adult population with potential for upskilling and reskilling. Luxembourg: Publications Office of the European Union

[356] The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators on Europe's digital performance. At high level, DESI addresses five interconnected policy areas for a digital economy and society (connectivity, human capital, use of internet services, integration of digital technology, digital public services). Its data collection is annual and allows tracking the evolution of Member States in digital competitiveness. More information: https://ec.europa.eu/digital-single-market/en/desi

[357] The Digital Economy and Society Index — Countries' performance in digitisation. Retrieved from https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

between rural areas and cities is still wide and virtually present in all Member States, somehow hindering economic developments and the uptake of digital technologies and online services[358].

The **gender gap** is also a complex challenge that requires targeted measures. The gender gap is particularly high in some of the fastest-growing and highest-paid jobs of the future, like computer science and engineering. The digitalisation of the economy is providing an unique opportunity for economic growth and for a greater inclusion of women in the labour market. Boosting the number of women in ICT is a major opportunity for the EU. The sector needs highly skilled employees and while women make up the majority of graduates from tertiary education they are underrepresented amongst ICT graduates[359]. However addressing the underlying causes of gender disparities in the digital and STEM fields requires targeted interventions early on, to raise awareness and interest[360], provide role models and tackle gender stereotypes[361].

In addition, the main findings of a recent study show that, despite the widespread use of the European Digital Competence Framework for Citizens[362], there is a **lack of a standard definition used for the measurement of digital competences** and also a **diversity of data collection methodologies and years of collection**[363], which poses methodological challenges and limitations to the existing knowledge base. This was further supported by Member States in the Structured Dialogue, which cited measurement and forecasting of digital skills gaps and needs as a challenging area for which support at EU level would be beneficial.

According to the same study, **different priority groups** can be identified depending on individual characteristics leading to a higher probability of having low or no digital skills (Table 2). However the variety of socio-economic characteristics of the priority groups identified by the study suggest that, in order to design effective skilling actions, focused research is required to better understand their needs, contexts and barriers to develop digital competences.

[358] Staff working document accompanying the long-term vision for the EU's rural areas - COM(2021)166 Final

[359] EIGE (2018). Women and men in ICT: a chance for better work–life balance - Research note. Luxembourg: Publications Office of the EU, 2018

[360] Wang M.T., Degol J.L. (2017). Gender gap in STEM: current knowledge, implications for practice, policy, and future directions. Educational psychology review, 29(1):.119-140.

Wang M.T., Degol J. (2013). Motivational pathways to STEM career choices: using expectancy–value perspective to understand individual and gender differences in STEM fields. Developmental Review, 33 (4) 4.

[361] European Parliament (2018). The underlying causes of the digital gender gap and possible solutions for enhanced digital inclusion of women and girls.

[362] Vuorikari R., Kluzer S., Punie Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes. Luxembourg: Publications Office of the European Union.

[363] Centeno C., Karpinski Z., Urzi Brancati C. (2022). Supporting policies addressing the digital skills gap. Identifying priority groups in the context of employment. Luxembourg: Publications Office of the European Union.

Table 2: Priority target groups for policy action

Group	Factor	Characteristics
1	Age and Education level	Young 16-24 years old, with low-level formal education, and NEETs (aged 16-35 not in employment, education or training)
2	Age	Individuals 55-64 years old
3	Education level	Individuals 25-64 years old with low-level formal education
4		Individuals 25-64 years old with medium-level formal education
5	Employment status	Individuals unemployed
6		Individuals inactive
7	Nationality	Nationals of non-EU countries
8	Place of living	Individuals living in rural areas
9	Employment status & occupation type	Individuals employed in semi-skilled and low skilled occupations

As highlighted by the stakeholders consulted in preparation of this initiative[364], stronger efforts and systematic policy actions are needed to improve the intelligence capacity at EU and Member States level and strengthen digital competence development at all levels of education and training.

3. Digital skills in education and training

As presented in section 2.1, Europe faces relatively low levels of digital skills and lower-than-desired attainments, both in terms of at least basic digital skills and of advanced digital skills. The root cause of this phenomenon can be traced to the provision of digital skills at various education and training levels across the EU. Educational systems should take responsibility in being primary actors to address this gap.

It has to be acknowledged that, in recent years, Member States have been putting forward policy reforms to evolve and adapt training curricula to the digital age. The inclusion of digital skills is now widespread, although with a great deal of variations from country to country and within countries. However, as the Structured Dialogue and Stakeholder Consultations show, additional efforts should be put forward to address the resisting skill gap across all population sectors.

[364] See Annex 2 for further information.

3.1 The provision of digital skills from early age to adults

To improve the educational offer we first need to look at the challenges each educational level face. Specific challenges require specific solution. The following paragraphs, therefore, present an overview of the provision of digital skills in all sectors of education and training. The overview follows a logical structure starting from early childhood education and care, passing by formal (primary and secondary) education, vocational education, higher education, to finish with adult learning.

3.1.1 Early Childhood Education and Care (ECEC)

Pre-school children are not detached from digital technologies. On the contrary, research shows that children are engaging with them at an **increasingly younger age**, even from the very early infancy (under the age of two)[365]. It is often the case that children approach digital devices out of curiosity and modelling the behaviour of others, and this leads to both opportunities and risks, especially when they are not guided and supervised.

For most pre-schoolers, the first point of contact to engage with digital tools is **at home**. They learn quickly in a primarily domestic environment by **observing and mirroring** the behaviour of siblings, younger relatives and adults close to them. Their learning strategy is often based on **trial and error**, which can potentially lead to a number of risks, for instance exposure to inappropriate content.

At home, children are inclined to use digital devices such as mobile phones, tablets, smart TV and, less often, computers. They consume digital content such as videos and games (both offline and online) and use specific software, such as drawing tools[366]. The online presence (or digital footprint) of young children (going from under the age of two up until schooling time) is mediated primarily through their parents and carers, who support them in accessing contents that suit their capabilities and interests. However, even very young children show adaptability and develop strategies to bypass limitations, helped by the accessible design of most touch-based interfaces. When supported, pre-schoolers can develop awareness on the risks of technology and fluency in their use.

Parents and carers have an important role and strong influence on how children use technology and what digital skills they develop. The more parents are digitally literate – and thus are at ease in the digital environment as well as aware of its risks and opportunities – the more children develop sense of agency and risk awareness[367]. The socio-economic level of the family is related to the availability of digital devices, the level of digital skills of caretakers and, consequently, the opportunity children have to approach the digital world, and the perception

[365] Chaudron S., Di Gioia R., Gemo M. (2017). Young Children (0-8) and Digital Technology - A qualitative study across Europe. Luxembourg: Publications Office of the European Union.

[366] Jackie Marsh (2016). The digital literacy skills and competeces of children of pre-school age. Media Education, 7(2):. 178-195.

[367] Chaudron S., Di Gioia R.,Gemo M. (2017), Young Children (0-8) and Digital Technology - A qualitative study across Europe. Luxembourg: Publications Office of the European Union.

of it as a useful learning tool. Families from higher socio-economic strata are more likely to possess a variety of digital tools, and to make use of them in several occasions (leisure- and work-related) thus facilitating a variety of behaviours for infants and children to model. However, higher affordances linked to socio economic status lead to inequalities from a very young age, limiting opportunities for children from lower socio-economic families to receive guidance on the opportunities and – crucially – risks of the digital world. Digitally competent professionals at ECEC level can counter-balance this trend by supporting children and their families.

Early Childhood Education and Care (ECEC) can play an important role to guide young children as well as their families in developing the digital skills they need for their interactions with digital technologies and in ensuring equity of opportunities. This is often recognised by parents, who are asking for assistance in developing and delivering the best strategies of mediation[368], and expect pre-schools and schools to provide children with the digital skills they will need in the future. ECEC policies and provisions should therefore focus on two strands: supporting the family as a whole in a safe and meaningful use of technology and making sure nursery schools and professionals are equipped to tackle issues related to the early use of digital devices.

In this context, the Structured Dialogue[369] confirms an emerging trend with some Member States promoting the development of digital skills at pre-school level, commonly using play-based approaches. **Learning through play** is a powerful methodology and can be applied to the domain of digital education in the early infancy. In this type of practices, children can explore, experiment, discover, and solve problems in imaginative and playful ways, while at the same time interiorising important concepts. Evidence suggests that learning through play happens when the activity is experienced as joyful, helps children find meaning in what they are doing or learning, involves active, engaged, minds-on thinking, as well as iterative thinking and has opportunities for social interaction. Learning through play with technology, including hybrid play (experiences that combine digital and physical), provides opportunities for young learners to acquire knowledge across a variety of contexts while developing a range of holistic skills, such as cognitive, creative, physical, social and emotional skills[370]. Equally, stakeholder consulted in preparation of this initiative highlighted the value of **unplugged digital education activities** which promote the development of digital skills without using digital devices. They can play an important role to translate abstract concepts of the digital world into tangible, concrete, sensorial inputs, helping children understand them. Although this is generally useful for all student levels, it is particularly effective when dealing with very young children.

[368] Scott, F.L (2021) Family mediation of preschool children's digital media practices at home. Learning, Media and Technology,. 47(2): 235–250.

[369] See Annex 3: Section 4.2.2.2, Digital skills initiatives in education settings

[370] UNICEF (2018). Learning through play. Strengthening learning through play in early childhood education programmes.

3.1.2 Primary and secondary education

Although national approaches might change, digital skills are largely addressed in formal education, and recognised as key throughout Europe.

The vast majority of countries includes **digital education strategies for primary, lower and upper secondary education**[371], which are evolving and, in general, expanding over time. This is due to the development of new technologies and to the increasing digitalisation level of our society, the response to the COVID-19 pandemic challenges and the need to adapt the competences developed at school to those needed in higher education and in the working environment. The implementation of strategies to develop digital skills in formal education varies across Member States. Countries in eastern and south-eastern Europe tend to address digital education within a broader strategy. Western, central and northern European education systems show instead a specific digital education strategy[372].

When looking at the provision, three main educational approaches currently exist[373]. The **cross-curricular approach** aims at having student develop digital skills in all/multiple subjects. A second approach is to introduce a **separate subject** devoted to the development of digital skills. For example, the inclusion of informatics (also known as *computer science*) in lower and upper secondary education is gradually emerging in educational systems around Europe[374]. Finally, a third approach consists in **including digital skills in an already existing subject**, like mathematics or science, language and social sciences, to avoid the creation of another subject in an already overcrowded curriculum.

Stakeholder consultations organised in preparation of this initiative[375] highlight that **each approach is valid,** that they do not exclude each other, and that **they can co-exist** and help in supporting learners' digital skills development. However, their implementation carries both advantages and disadvantages, and often depends on the level of education: while a combination of approaches is commonly adopted at primary level, disciplinary specialisation becomes more prominent at secondary level, but it is not always offered to all students equally. Each approach also has a different impact on learners' digital skills and learning outcomes, depending on its implementation detail, and on teachers' required competence level.

In more details, a quarter of **European countries combine two approaches** or all of them[376] at primary level. The cross-curricular approach covering the most transversal digital skills (e.g. digital literacy and computational thinking) usually coexist with the presence of a dedicated

[371] European Commission/EACEA/Eurydice(2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[372] Ibid.

[373] Consistent with the Eurydice report (2019) on digital education, also the Structured Dialogue (Annex 3) analysis revealed considerable diversity of curricular approaches across MS.

[374] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[375] See Annex 2 for further details.

[376] Joint Research Centre (2022). Reviewing Computational Thinking in Compulsory Education, JRC Report. Luxembourg: Publications Office of the European Union.

subject for more specialised competences. This is facilitated by the fact that teachers in primary school are often covering several subjects at once, allowing for a stronger integration of teaching strategies. At lower and upper secondary level, the trend is instead to favour a more specialised approach, and a separate subject like informatics becomes more common.

However, a lack of a compulsory subject on digital skills in primary schools could represent an obstacle for students failing to complete secondary education to acquire even a basic digital skillset. This could prevent them from accessing better reskilling, upskilling and working opportunities throughout their career.

Regardless of curricular choices, creating a specific subject or making time for elements of this subject transversally or within another subject is only a first step to ensuring that digital skills are developed. Further challenges arise in ensuring **assessment, quality teaching**, **relevant resources**, **gender balanced uptake and representation**.

The cross-curricular approach

Due to their nature, digital skills can be disseminated, developed and tested throughout several "traditional" subjects. This approach entails the involvement and coordination of several teachers at the same time. This could represent both an advantage and a disadvantage.

On the one hand, students could benefit from being able to **experience digital tools** and develop digital thinking applied to different topics and in different situations. Teachers could also build upon digital activities to introduce other forms of cross-curricular competences (critical thinking, problem solving, etc.)[377].

On the other hand, if teachers fail in coordinating the time-allocation reserved for digital competences and the related activities, this could result in repetitions, gaps and to a disorganised learning pattern. This could also negatively affect the learning process of the associated subjects. Moreover, this approach risks allowing just a superficial comprehension of the digital tools and subjects. Whereas the focus is on operational and applied skills (such as retrieving, analysing and visualising data, managing communication), students might lack time to fully understand the fundamental mechanisms at the base of digital technologies, their working patterns, issues and opportunities.

The involvement of multiple teachers in conveying digital competences to students means that the entire **teaching staff has to be adequately skilled** in digital technologies. This represents a challenge especially in those subjects that did not have traditional affiliation with the digital world, and potentially for teachers approaching the end of their career. Even if the required level could change depending on the organisation of the cross-curricular digital activities, all teachers should be supported in developing their digital skillset and in effectively transmit it to students.

[377] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

Digital skills as part of a dedicated subject

Addressing digital skills in a dedicated subject allows for both ensuring that a **certain level of digital skills is reached by all students** and favours **higher specialisation and more advanced digital competences** than in the cross-curricular approach. This is especially relevant for those skills that require dedicated learning resources (IT equipment, specialised software) and have specific teaching needs.

Moreover, a dedicated subject allows better assessment of learners' performance and of their achieved level of digital competence. **Assessment can be calibrated** to the curricular activities covered during lessons.

On the down side, if digital skills are only taught in a separate subject with no integration to other educational activities performed at school, there is the **risk that these competences remain isolated** and do not show their potential application to other fields.

With this approach, teaching staff are required to have **a higher degree of specialisation**, particularly in secondary education. This could represent an obstacle for schools and teachers alike. Qualified teachers either require specialist knowledge in digital-related fields (computer science and other related disciplines) or to have participated in retraining schemes within the education system**Error! Bookmark not defined.**. In any case, continuous teacher training as part of continuing professional development schemes is necessary to ensure good-quality teaching and learning.

Digital skills within another subject

The inclusion of digital skills and subjects into another pre-existing subject, such as Mathematics or Science and Technology, avoids the burden to create another subject in an already overcrowded curriculum. This allows leaving other subjects unaffected and it is best suitable when performed in conjunction with subjects that could immediately benefit from a higher proficiency in digital skills. Stakeholder consultation[378] show that this approach is perceived as **easier to implement** than the previous approaches, because it is less disruptive of existing curricular arrangements.

However, there is a **risk of competition** between the curriculum priorities and time allocation of the associated subject, especially when the teachers do not possess the appropriate skill level. When facing time constraints, teacher might prefer to dedicate more time to their original subjects, leaving gaps in the learning process of pupils. Associated subjects could also be negatively impacted by a reduction of time dedicated to them, when alternative solutions are not implemented to mitigate it.

Digital competence assessment and quality teaching

A fundamental step in educational strategies consists in the **assessment phase**. This serves to certify the level of competences reached by students and to collect useful data to fine-tune

[378] See Annex 2.

education strategies, support teachers and students. **Quality of teaching** could also be assessed to evaluate gaps, training needs and additional support to teachers.

Traditionally, **summative assessment**[379] consists of grading, testing and promoting procedures to verify the level of digital skills acquired by their students, and it usually occurs *after* a learning module or theme. It is a useful indicator of the effectiveness of educational activities but does not necessarily help students *throughout* their learning process.

Formative assessment[399] aims at evaluating students *while* participating in the learning process. Formative assessment is a method of collecting feedback from learners to adapt the teaching to meet student needs and has been considered in the last two decades as an essential component of classroom work as its development can raise standards of achievement[380]. It usually entails a form of continuous evaluation throughout learning activities. Effective formative assessment might require teachers to use a variety of tools: in some cases, formative assessment requires quick feedbacks on the students' capabilities, for which automated tools may play an important role; in other cases, more reflective strategies may imply the use of open questions or self-assessment. A wide use of tools can be challenging for schools and, importantly, for teachers, especially when they did not receive the necessary guidance.

Another way to assess digital competences, usually related to summative assessment, is represented by **national standardised testing**. These tools are often used to achieve a double goal: to certify the proficiency levels of pupils and students at the end of a particular stage of education or school year and to assess the **quality of teaching** at regional/national level[381]. Although this is a widespread practice for education policy, it can also present challenges. Results of tests can be used as access criteria to higher education, even though their design is often not tailored to this purpose. Schools can be unjustifiably affected by test results, especially in difficult social areas, whose challenges and needs could not be taken appropriately into account. If assessment strategies are only based on standardised testing, they might distort perceptions on important skillsets for students, causing them to focus on passing the tests rather than to develop relevant capabilities[382].

The outcome of the Structured Dialogue confirms that, at the primary and secondary level, assessment of digital skills is often neglected, sometimes only taking the form of formative assessment. Indeed, **only half of European countries include any kind of assessment** procedures for digital skills at primary or secondary school level[383]. Some countries never test digital competences, while others only assess them in secondary education. Despite the cross-

[379] Siarova, H.; Sternadel, D.; Mašidlauskaitė, R., (2017). Assessment practices for 21st century learning: review of evidence, NESET II report, Luxembourg: Publications Office of the European Union.

[380] Black, P., & Wiliam, D. (2005). Inside the black box: Raising standards through classroom assessment. Granada Learning.

[381] European Commission/EACEA/Eurydice(2019). Digital Education at School in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[382] OECD (2013). Synergies for Better Learning: An International Perspective on Evaluation andAssessment. Paris: OECD Publishing.

[383] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

curricular nature of digital skills, testing is not homogeneous, and tends to involve preferentially students in certain educational sectors, such as STEM.

Only three education systems (France, Malta and Austria) assess students' digital competences through specific national tests related to individual student achievement in lower secondary education. In the Flemish Community of Belgium (lower secondary education), the Czech Republic, Estonia, France (primary education), Luxembourg and Finland digital competences are assessed through sample tests that aim at monitoring the quality of the education system rather than measuring the attainment levels of individual students[384].

Teachers are not always guided in how to correctly assess digital competences in their students. Only few educational systems developed standard approaches and guidelines and perform standardised national tests. **Student digital competences are evaluated rarely** through specific national tests related to individual student achievement in lower secondary education. More often, digital competences are assessed through sample tests that aim at monitoring the quality of the education system rather than measuring the attainment levels of individual students.

3.1.3 Vocational education and training

Vocational education and training (VET) serves as a fundamental tool in both the skilling of young professionals and in reskilling and upskilling of adults. As such, it is of crucial importance in addressing the present and future challenges faced by our society in the skill area.

Recent years saw a **growing effort to promote the digital transformation** of this sector. For instance, a CEDEFOP study found that between 2011 and 2018, all but one of the EU+ countries[385] adopted and started implementing policies to promote digital competence in initial VET (IVET)[386], commenced in lower secondary education. The 2020 VET Council Recommendation[387] put the focus on two aspects: (i) providing training programmes offering digital skills to trainees, and (ii) foster the digitalisation of training activities. Many Member States[388] are implementing these provisions through national plans for VET; therefore, future curricula and programmes can be expected to have stronger elements of digital education included. From a first analysis of the submitted national implementation plans of the Council Recommendation on VET and the Osnabrück Declaration[389]**,** 18 EU-27+ countries cover **reviewing and modernising VET standards, curricula**, programmes and training courses in

[384] For additional details see: Structural indicators for monitoring education and training systems in Europe - 2022 | Eurydice (europa.eu)

[385] EU27 plus Iceland, Norway, and the United Kingdom.

[386] CEDEFOP (2020). Key competences in initial vocational education and training: digital, multilingual and literacy.

[387] Council Recommendation of 24 November 2020 on vocational education and training (VET) for sustainable competitiveness, social fairness and resilience - 2020/C 417/01.

[388] Austria, Estonia, France, Germany, Hungary, Italy, Latvia, Lithuania, Malta, Netherlands, Poland, Portugal, Romania, Slovenia and Spain

[389] Osnabruck declaration 2020

their countries to bring them closer to the skills needed on the labour market and in personal careers and development of individuals. 16 EU-27+ countries plan to integrate **digital skills and competences** in VET standards and curricula.[390]

Students from IVET show levels of digital skills close to the ones of students in general secondary education[391]. However, the nature of vocational education requires that the digital capabilities, tools and competences should be immediately applicable in the working environment once the training cycle is concluded. This means that **advanced and more specialised digital competences** (such as CAD/CAM programming, robotics, additive manufacturing, 3D printing, artificial intelligence and cybersecurity) should be developed by students during their VET attendance.

However, **basic digital skills** should equally be part of the formative offer of VET. Reaching a basic proficiency is a fundamental step to be able to access further training, reskilling and upskilling opportunities. Provision of digital skills in IVET may contribute to close the gap of digital skills in the EU workforce by **matching the demand of the labour markets**, thus improving the employability of employees and **promoting equality and social inclusion**. The COVID-19 pandemic accelerated the transition to digital ways of working and learning, leaving **digitally illiterate workers at risk** of being excluded from the job market and facing difficulties in reskilling and upskilling.

Similarly to general secondary education, digital skills could be developed by students in VET in a **cross-curricular** way, or **through a dedicated subject[392]**. Indeed, evidence from a Cedefop show that in IVET, digital competence is most commonly integrated in other subjects (35% of programmes) rather than as a stand-alone subject. Regardless of the approach chosen, data show that in some cases VET curricula over-emphasise programming/coding over more abstract digital competences, thus failing to address important digital skills that could be of use also for non-computationally specialised students[393].

Shortage of digitally qualified IVET teachers, as well as lack of adequate teaching material could also represent a risk for the pass-through of advanced and specialised digital skills, as recognised by experts.

[390] EU-27+ countries refer to the 25 countries that submitted NIPs (23 Member States plus NO and IS, BE submitted 2 NIPs, for BEfr and BEfl.

[391] CEDEFOP (2022). Evidence supporting the upcoming proposal for a Council Recommendation on improving the provision of digital skills in education and training. Draft working paper.

[392] See the previous section on Primary and Secondary Education for an overview of different approaches.

[393] Bocconi S., Chioccariello A., Kampylis P., Dagienė V., Wastiau P., Engelhardt K., Earp J., Horvath M.A., Jasutė E., Malagoli C., Masiulionytė-Dagienė V., Stupurienė G. (2022). Reviewing Computational Thinking in Compulsory Education. Luxembourg: Publications Office of the European Union.

3.1.4 Higher education

European higher education system must be one of the focuses of the policy action to increase the digital skills level of EU citizens. Specific targets[394] of the European legislation on higher education by 2030 aim at reaching at least 45% of 25-34 year-olds with tertiary education attainment. Higher education learning offer has to be both general and sector specific[395]. However, universities and higher education institutions might face significant challenges in developing digital skills across multiple levels and disciplines, in offering advanced and specialised digital competences, and in implementing lifelong learning provisions. Realising these goals means that universities should adopt a holistic and comprehensive (*whole-institution*[396]) approach – making use of their whole educational and organisational structures – in adapting their offer to be both general and specialised[397]. This contributes to create supportive learning environments where the institution as a whole is active on the (green and) digital transition.

The higher education system should be part of a coherent and far-reaching educational path, aiming at a high degree of integration with the provision offered at lower educational levels. Digital skills should therefore be implemented at all levels and throughout all disciplines, even non-ICT ones, adopting when possible a multidisciplinary approach.

Despite the transversal importance of digital skills for most professions, and although Higher Education Institutions are aware of the importance of digital skills for their students, a minority of institutions had developed in 2019 formal practices and curricula integrated in a transversal way across faculties.[398] This is supported by similar findings from an EUA (European University Association) survey on digitally enhanced learning and teaching in European Higher Education Institutions: prior to the Covid-19 pandemic, 90% of higher education institutions were already cognisant of the importance of equipping students with digital skills for their future careers, i.e. by providing general digital literacy and study-specific digital skills in their educational offer. However, the survey also found that general digital skills education offer was often not integrated into study programmes and provided on a voluntary basis.[399] Universities typically provide students with **digital skills through dedicated programmes** for specialists in Information and Communication Technologies (ICT) – although results from the Structured Dialogue show that this trend is changing and Universities are committed to providing transversal courses on general digital skills. A lack of digital provisions in non-specialist

[394] Council Resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021-2030), 2021/C 66/01 (2021),

[395] Proposal for a council recommendation on learning for environmental sustainability, COM(2022) 11 final

[396] Buckler, C.; Creech, H., (2014). Shaping the Future We Want. UN Decade of Education for Sustainable Development (2005-2014): Final Report; Paris: UNESCO.

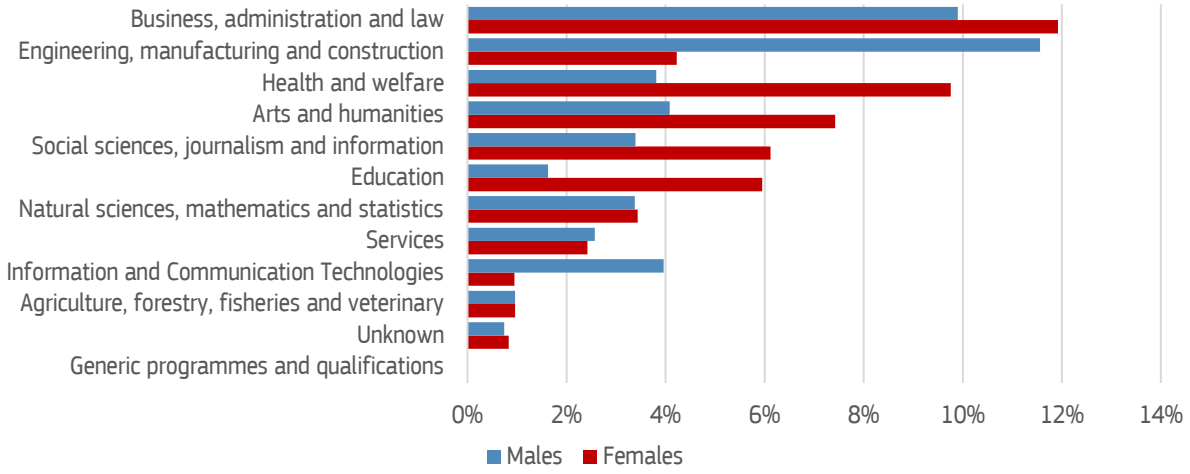
[397] For instance the proposal for a Council Recommendation on learning for environmental sustainability (COM(2022) 11 final) recognises that whole-institution approaches where sustainability is embedded in all processes and operations are not yet widespread across educational institutions, also due to insufficient funding and support.

[398] Bastos, S., De Oliveira, H., Silva, M., & Azevedo, L. (2019, November). Soft-digital skills in higher education curricula. In Proceedings of the European Conference on e-learning.

[399] Gaebel, M., Zhang, T., Stoeber, H., & Morrisroe, A. (2021). Digitally enhanced learning and teaching in European higher education institutions. Survey report.

courses could lead to a limitation for students in other disciplines to acquire basic to advanced digital skills. This is even more significant noting that less than 5% of students enrol in ICT-related programmes, and that this sector shows a low participation of women (see Figure 15). In a position paper received in preparation of this initiative, EUA states that "In higher education, digital skills are to be seen as part of general learning and teaching provision"[400].

Figure 15: Distribution of EU tertiary education students by broad field and sex



Source: Eurostat

As confirmed by the Structured Dialogue[401], Member States are putting effort to (i) increase the level of **digital skills across a broad range of higher education courses** and (ii) boost the number of students acquiring **advanced digital skills**. In particular, about one third of Member States referred to the development of courses supporting the provision of digital skills in non-ICT programmes, while two-thirds referred to initiatives designed to increase the number of ICT professionals, including women. In about half of Member States, both approaches are implemented, demonstrating the importance of both basic and advanced digital skills in higher education.

Higher Education institutions are adapting to the demand for short and tailored provision for ICT specialists. Half of respondents to EUA's 2020 survey stated that their institutions provided short courses and reported a growing demand for these to operate in blended mode (65%) targeting lifelong learners (55%).[402] Compared internationally, Europe's higher education institutions provide a high number of short courses to train ICT specialists in various fields.[403]

[400] EUA (2022). Digital skills – improving their provision. EUA's feedback to the European Commission call for evidence,.

[401] See Annex 2: Section 4.2.2.2 Digital skills initiatives in education settings.

[402] Gaebel, M., Zhang, T., Stoeber, H., & Morrisroe, A. (2021). Digitally enhanced learning and teaching in European higher education institutions. Survey report.

[403] Righi, R., Lopez Cobo, M., Papazoglou, M., Samoili, S., Cardona, M., Vazquez-Prada Baillet, M. and De Prato, G., (2022)Academic Offer of Advanced Digital Skills in 2020-21. International Comparison, EUR 31043 EN, Luxembourg: Publications Office of the European Union.

Advanced digital skills offered as part of the ICT curricula in Europe include areas in high demand such as artificial intelligence (AI), high-performance computing (HPC), cybersecurity (CS) and data science (DS). These technological domains are often taught independently on each other[404], with the exception of AI and data science, for which significant overlaps exist in techniques and applications (data extraction and analysis, machine learning). This leads 1 in 8 university courses to cover these domains in a common subject.

Data on available university courses in the EU show that **artificial intelligence**, including robotics, automation and machine learning, is offered relatively widely across Europe[405], at bachelor's and especially at master's level. The exact distribution of contents is tailored to the specific needs of the curriculum. For example, ICT curricula show a balanced presence of robotics and automation, machine learning, AI applications and ethics, while Engineering has a prevalent presence of robotics and automation. Several Commission policy initiatives aim at creating a favourable environment to promote AI and data related skills. These include traineeships in digital areas (Digital Education Action Plan[406]), specialised education and training programmes (Digital Europe Programme[407]), PhD programmes and AI excellence centres (Horizon Europe[408]), doctoral and postdoctoral networks in AI (Marie Skłodowska-Curie actions[409]).

High-performance computing allows, using parallel computing, cloud computing and supercomputers, to manage large amounts of data and to solve complex computational tasks. It is of crucial importance for pure research (e.g. in physics, chemistry, medicine and engineering) but has also widespread applications to a variety of business areas. The EU (and Europe in general) fall short of the US in terms of offer of advanced HPC skills in universities.

Despite its social and economic importance, the **academic offer of cybersecurity** courses is less frequent in the EU than in other parts of the world (such as the US and the UK), and often to a lower degree of specialisation[410]. In addition, skills mismatches between education and training and the needs of the labour market, aggravated by the lack of a common language on

[404] Ibid.

[405] According to JRC research, the offer of AI and robotics courses in the EU is comparable to the one in the UK and US, especially at master's level.

Righi R., Lopez Cobo M., Papazoglou M., Samoili S., Cardona M., Vazquez-Prada Baillet M., De Prato G. (2022). Academic Offer of Advanced Digital Skills in 2020-21. International Comparison, Luxembourg: Publications Office of the European Union.

[406] COM/2020/624 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Digital Education Action Plan 2021-2027, Resetting education and training for the digital age

[407] Regulation (EU) 2021/694 of the European Parliament and of the Council of 29 April 2021 establishing the Digital Europe Programme and repealing Decision (EU) 2015/2240

[408] Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013

[409] Council Decision (EU) 2021/764 of 10 May 2021 establishing the Specific Programme implementing Horizon Europe – the Framework Programme for Research and Innovation, and repealing Decision 2013/743/EU

[410] For a list of available Cybersecurity academic courses in the EU, see the Cybersecurity higher education database developed by ENISA: https://www.enisa.europa.eu/topics/education/cyberhead#/

cybersecurity skills, complicates career pathways in cybersecurity. Important policy initiatives such as the NIS2 Directive[411], the European Cybersecurity Act[412] and the new EU Cyber Resilience Act[413] will trigger a market need for cybersecurity specialists in sufficient number and with the right skillset.

Data science, including big data, statistical modelling, data analytics and machine learning, show many applications and are in high demand in the EU. Universities across the EU offer related courses to a similar degree when compared to the leading countries (US and UK). Moreover, as data science has significant overlaps with other ICT disciplines, it is often seen as a **facilitator** to introduce AI, HPC and cybersecurity concepts in non-ICT programmes.

To support the development of education and training programmes in cutting-edge technologies, the European Commission is currently supporting excellence in higher education institutions via the Digital Europe Programme (DEP). The aim is to make European higher education institutions world leaders in training digital specialists and to increase the capacity of the training offer for advanced technologies. This should also lead to the development of a dynamic digital ecosystems where academic excellence, research and innovative industries work together to attract and retain the best talents worldwide.

The first two DEP calls for masters[414] and short term training courses[415] in key digital technologies awarded 21 new consortia gathering 230 partners in all, including businesses, universities, research and training centres.

The third call of the Digital Europe Programme[416] provides support to consortia to design/deliver Bachelor's and Master's programmes and self-standing modules/courses in key digital areas. One of the focus areas of the third call is the development/delivery of interdisciplinary programmes, targeting the acquisition of advanced digital skills in specific sectors (e.g. agriculture, energy, finance, health, law, media and culture, manufacturing, sustainable and autonomous mobility, and space). The content of the programmes will help students to deploy and use technologies in an empowered way in their work in these specific sectors. Another focus area is the conversion programme(s) for students graduated from non-ICT fields to access specialised Master's programmes in the key digital areas.

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411 Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148 (NIS 2 Directive)

412 Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU), OJ L 151, 7.6.2019, p. 15–69

413 COM(2022) 454

414 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/digital-2021-skills-01-specialised

415 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/digital-2022-training-02-short-courses

416 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/digital-2022-skills-03-specialised-edu

The **low participation of women** in the ICT higher education sector was raised as a common challenge and concern in the Structured Dialogue[417], and all Member States mentioned examples of ongoing initiatives to enhance female enrolment and career development. However, with few exceptions, these initiatives do not take a systematic approach to gender equality.

Available data show that Europe suffers from a **lack of expertise in teaching** advanced digital technologies and integrating these technologies across curricula and in specialised courses. A JRC analysis mapping provision in digital areas such as AI, cybersecurity or high performance computing shows that in 2019-2020 the UK alone was offering almost as many specialised Master's programmes in AI as the whole EU27[418]. Moreover, especially for advanced ICT specialists, the Structured Dialogue confirm existing differences with regards to the quality and content of training or recognition of skills. This has an impact on the certification of such skills and mutual recognition of qualifications within and between Member States.

Finally, opportunities are arising for higher education institutions to provide **lifelong learning**. Small courses leading to micro-credentials can particularly help provide flexible, accessible learning opportunities for digital skills for a variety of learners, including adults[419].

3.1.5 Adult learning

Skills are a key foundation to the European economy and society by preparing people to seize opportunities and drive the green and digital transition. Considering the existing skills shortages and the needs of the labour market in the light of the recovery[420], **upskilling and reskilling on digital skills** play a central role[421]. The 60% EU headline target[422] can help boosting adult participation in learning, including on digital skills, which currently remains low across EU countries[423].

Participation of the hard-to-reach groups in up- and reskilling (such as elderly people, people with disabilities, those living in deprived or remote/ and rural areas, migrants, or other minority

[417] See Annex 2: Section 4.2.2.2 Digital skills initiatives in education settings.

[418] Righi R., Lopez Cobo M., Papazoglou M., Samoili S., Cardona M., Vazquez-Prada Baillet M., De Prato G. (2022). Academic Offer of Advanced Digital Skills in 2020-21. International Comparison, Luxembourg: Publications Office of the European Union.

[419] Council Recommendation on a European approach to micro-credentials for lifelong learning and employability, COM/2021/770 final

[420] A recent report from the European Investment Bank shows that employers keep reporting the lack of staff with appropriate skills as one among the top obstacles to investment. For further information see European Investment Bank (2022). EIB Investment Report 2021/2022.

[421] CEDEFOP (2021). Digital skills: Challenges and opportunities.

[422] The target states that at least 60% of adults in the EU should have been participating in learning over the previous 12 months by 2030.

[423] EU-27: 37% in 2016 (the latest available data with the indicator a 12 month reference period). The 2016 Adult Education Survey shows that only a few countries reached 50% in that year (AT, DK, FI, HU, NL, SE).

groups[424]) remain a concern for all Member States. For some, the onset of the pandemic also brought an additional challenge in upskilling older people of working age**.** Many Member States are implementing new initiatives addressing this need, including through action carried out in collaboration with social partners and, to a less extent, industry, but these initiatives are often not structural and comprehensive. To reach those hardest to reach it is key that different types of organisations join forces[425]. Beyond the digital inclusion dimension, raising awareness of new realities and skills demands in the world of work plays a key role in adult learning[426].

Concerns have been expressed about the negative short and long-term impact of the pandemic on participation in adult learning and inequalities in accessing it[427]. For instance, an OECD report finds that, under certain assumptions, the pandemic reduced workers' participation in non-formal learning by an average of 18 percent, while the corresponding decrease in informal learning is about 25 percent[428]. These results are consistent with recent Eurostat statistics, showing that the EU adult participation in formal and non-formal education and training in the last four weeks decreased from 10.8 percent in 2019 to 9.2 percent in 2020 to then go back to 10.8% in 2021[429]. Additionally, during the pandemic, the share of online adult learning has significantly increased from 8% in 2019 to 13% in 2020, compared to very slow progress before[430]. Results also indicate that the increase of online adult learning has been especially pronounced among women, individuals aged 55 to 64, and less educated adults[431]. Outcomes of the open public consultations of the Digital Education Action Plan 2021-2027 confirmed that the emergency situation caused by the pandemic forced and in some cases encouraged many individuals that had no previous experience in using distance and online learning to get at least some exposure to it. Furthermore, practically all respondents already using distance and online learning before the crisis continued to do so[432]. In a nutshell, evidence shows that in most EU countries the pandemic was associated with a higher proportion of adults taking online courses.

[424] The concept of hard-to-reach groups appeared quite frequently in the Structured Dialogue. Member States referred to it by thinking, first, at those being geographically hard to reach and, secondly, at those being hard to reach socially. It is important to note however that some individuals may be hard to reach in both senses.

[425] Commission Staff Working Document, Evaluation of the Council Recommendation of 19 December 2016 on Upskilling Pathways: New Opportunities for adults.

[426] CEDEFOP (2020). Challenging digital myths: first findings from Cedefop's second European skills and jobs survey. Policy brief. Luxembourg: Publication Office of the European Union.

[427] European Commission (2020). Adult learning and COVID-19: Challenges and opportunities. ET 2020 Working Group on

Adult Learning - Di Pietro G., Karpiński Z., Biagi F. (2021). Adult learning and the business cycle. Luxembourg: Publications Office of the European Union.

[428] OECD (2021). Adult learning and COVID-19: how much informal and non-formal learning are workers missing?

[429] Eurostat (2021): Statistic explained - Eurostat (europa.eu): Adult learning statistics. Importantly, these data on participation use another methodology (4 weeks reference period) than the current 60% headline target (one year reference period). Additionally,

[430] Data on adult participation in online learning come from calculations based on Eurostat (2021): Database – Digital Economy and Society – Eurostat (europa.eu): Survey on the use of ICT in households and by individuals [ISOC_I] in the years 2017, 2019, 2020 and by considering only individuals aged between 25 and 64. For additional information about changes in participation in online adult learning in 2020 see: Di Pietro G. and Karpiński Z. (2021). Covid-19 and online adult learning. Luxembourg: Publications Office of the European Union.

[431] Di Pietro G., Karpiński Z. (2021). Covid-19 and online adult learning. Luxembourg: Publications Office of the European Union.

[432] See Annex 2 for further details.

However these are shares out of the relatively small adult population that does participate in learning. While the shift in adult learning towards online activities is likely to continue[433], any further increase in the future depends very much on how many people will actually develop at least basic digital skills[434].

Over the past two years, the Commission and the Council put forward several initiatives to support Member States in further developing actions in the field of adult learning, including on digital skills, such as the Resolution on a new agenda for adult learning [435] and the two Council Recommendations on individual learning accounts[436] and on the European approach to micro-credentials[437]. The development of basic skills including digital competences for low-skilled adults was also underpinned by the Council Recommendation on Upskilling Pathways[438]. Progress towards the adult learning target are supported by different EU funds, including the European Social Fund Plus (ESF+) and the Recovery and Resilience Facility (RRF)[439], but at its basis there is a strong need for **comprehensive policies addressing the challenges of the EU adult learning system** such as low participation rates, difficulty of access, inadequate funding or insufficient paid training leave policies[440].

When it comes to digital skills, in the majority of Member States, strategic policies targeting the provision of digital skills for adults are usually formulated and assessed by the same ministry that has institutional responsibility for the overall education and training system (i.e. Ministry of Education)[441]. This approach entails the possibility to integrate adults' digital skills learning into the overall policy-making for education but has the risks of underestimating the importance of specific measures and funding that might be needed in a lifelong learning perspective compared to primary, secondary and higher education.

[433] Eurostat statistics shows that interest in online education keeps growing in the EU. For further information see Eurostat (2022): News article – Eurostat (europa.eu): Interest in online education grows in the EU - Lockee B.B. (2021). Online education in the post-COVID era. Nature Electronics, 4 (1)

[434] Boeren E., Roumell E.A., Roessger K.M. (2020). COVID-19 and the future of adult education: An editorial. Adult Education Quarterly, 70(3)

[435] Council Resolution on a new European agenda for adult learning 2021-2030 2021/C 504/02

[436] Council Recommendation of 16 June 2022 on individual learning accounts 2022/C 243/03

[437] Council Recommendation of 16 June 2022 on a European approach to micro-credentials for lifelong learning and employability 2022/C 243/02

[438] Council Recommendation of 19 December 2016 on Upskilling Pathways: New Opportunities for Adults, 2016/C 484/01, OJ C 484, 24.12.2016, p. 1–6

[439] Nearly all Recovery and Resilience Plans endorsed by the Commission and approved by the Council include measures on adult learning, but the importance allocated to it varies a lot. Common measures include upgrading policy frameworks, providing support for demand-based individual upskilling and use of public employment services to fund investments for employed and unemployed people.

[440] OECD (2021). Skills Outlook- Learning for Life. Chapter 4: Promoting interest and participation in adult learning.

[441] This is the most common approach in the EU Member States, for example, in Bulgaria, Czech Republic, Estonia, Greece, Latvia, Lithuania, the Netherlands, Romania and Slovakia. Source: Beblavý M., Bačová B. (2022). Literature review on the provision of digital skills for adults. EENEE report. Luxembourg: Publications Office of the European Union.

A recent literature review on adults' digital skills[442], reveals that policies on the topic are usually articulated through **generic strategic documents on digitalisation**[443], even though countries, also considering the impact of the Covid-19 crisis, are increasingly developing **specific digital skills strategies for adults,** for instance the '10 Year Adult Literacy, Numeracy and Digital Literacy Strategy' of Ireland[444]. In some countries, however, adult learning is not a priority and remains underfunded[445]. Equally a comprehensive and functioning system for monitoring participation and learning outcomes is often missing, which makes it hard to gather interest or develop effective targeted interventions[446].

Across countries, policies pay particular attention to the inclusion of vulnerable groups like senior citizens and NEETs (not Employed, in Education or Training) and to address transversal inequalities such as the gender divide. Individuals are most often targeted as both citizens and workers, with governments concerned about equipping them with skills needed for societal and economic transformations. Most countries pursue a **mixed approach** supporting adults' education pathways provided by training institutions, employers, multi-stakeholder partnerships or, very often, regional open learning centres. There is also an increase in the availability of support provided for individual learning through vouchers, individual learning accounts or similar approaches. Despite these promising examples, many initiatives are bottom up, demand-led and often not well coordinated[447].

Analysing the **provision of digital skills for adults** in the EU and across Member States is not an easy endeavour. Literature on adults' digital skills is rich but evidence mapping the courses and programmes available and analysing their effectiveness is limited, often focusing on specific target groups or on more advanced digital skills[448].

A transversal analysis of the available evidence highlights that the provision is **scattered** among a variety of providers **and uneven** between countries and target groups. Even where there is a plethora of options available for adults, there is a **challenge of accessibility**. For instance, access to training is easier for employees of large companies than for those in small or medium enterprises. For those workers who have no or loose links to an employer, the challenge of accessing training is clearly greater. A similar disadvantage is visible for adults with low level of education and for those living in rural areas who both participate in training significantly less than people with higher levels of education and living in towns and cities. Some Member States

[442] Beblavý M., Bačová B. (2022). Literature review on the provision of digital skills for adults. EENEE report. Luxembourg: Publications Office of the European Union.

[443] This is the approach taken, for example, in Digital Austria in 2050, Digital Bulgaria 2025, Germany's Digital Strategy 2025, Dutch Digitisation Strategy 2.0, Denmark's Digital Growth Strategy or the Strategy of the Digital Transformation of Slovakia 2030.

[444] Adult Literacy, Numeracy and Digital Literacy Strategy for Ireland (solas.ie)

[445] Transversal analysis of the 2020 Member States Reports on National Developments in Adult Learning and on the implementation of the Skills for Life flagship initiative.

[446] Ibid.

[447] Beblavý M., Bačová B. (2022). Literature review on the provision of digital skills for adults. EENEE report. Luxembourg: Publications Office of the European Union.

[448] Ibid.

have started to address this challenge of accessibility through the creation of aggregators[449] and/or virtual providers[450] that, however, have limited effectiveness, especially among those lacking basic digital skills[451]. Across Member States there are also regional or place-based networks of providers covering both basic and more advanced digital skills whose activities are rarely evaluated and assessed.

As a consequence, **multiple barriers still exists** for those that would most need this provision (e.g. costs of training, time for the training, lack of certainty about its quality and recognition, insufficient tailoring of training offers to individual needs, etc.)[452]. Often low-skilled people or those living in disadvantaged regions are the least able to take advantage of skills development opportunities unless such programmes are targeted at their particular needs in terms of content, access, support and outreach[453].

To conclude, evidence on what is currently offered in terms of digital skills provision for adults and on the effectiveness of existing policies and interventions is limited. **Further research at European and national level** would support in gathering intelligence and identify good practices that could be shared across Europe.

More in general, considering adults' level of digital skills and their general participation in lifelong learning activities, **integrated financial and non-financial support** is needed to incentivise more adults to participate in learning and further develop their digital skills. The relationship between digital skills and employment rates in the European Union is statistically significant[454] and the correlation between the share of GDP invested in adult learning and the adult learning participation rate is strong[455]. Equally findings from recent surveys shows that better financial incentives or support are considered as a key instruments to encourage adult participation in training, including on digital skills[456].

Among the respondents to the 2016 EU Adult Education Survey and the 2019 OECD Survey of Adult Skills who have not attended any adult learning opportunity in the least twelve months, four out of five declared not to be interested ('disengaged' from learning in the terminology of

[449] Aggregators are programmes and projects that do not provide their own trainings but serve as aggregators of content provided by others.

[450] Virtual providers, as opposed to aggregators, not only provide information and links to courses or providers but are directly involved in the provision. They are frequently publicly run and/or funded.

[451] Weakness of aggregators and virtual providers is that they are most likely to be successfully accessed by those who already possess some level of digital skills.

[452] European Commission (2022). The EMCO-EDUC Multilateral Surveillance 2022 - Thematic discussion on strengthening adult learning.

[453] Clancy S., Studená I., Vatrella S. (2020). The Upskilling Pathway. In Europe's Lifelong Learning Markets, Governance and Policy. Palgrave Macmillan, Cham.

[454] Bejaković P., Mrnjavac Ž. (2020). The importance of digital literacy on the labour market. Employee Relations: The International Journal.

[455] European Commission (2020). Workforce skills and innovation diffusion: trends and policy implications. Annex 8. See also European Commission (2020). Adult Learning Statistical Synthesis Report.

[456] Cedefop (2020). Perceptions on adult learning and continuing vocational education and training in Europe. Second opinion survey – Volume 1 (europa.eu).

the OECD Skills Outlook 2021)[457]. A transversal analysis of the 2020 Member States Reports on National Developments in Adult Learning confirms that measures increasing the **attractiveness, flexibility and recognition of the avaiable quality assured provision** would boost particiation, especially from vulnerable groups or lower skilled individuals. Measures aimed at **increasing individual awareness of personal skills needs** and possible impact of the training on employability and connected factors would be equally beneficial[458]. From this point of view validation and certification of digital skills remains a priority in the EU and across Member States.

3.2 The role of informatics

It is internationally recognised that there is a fast emerging trend in educational systems to include Informatics as part of national curricula and as part of the general education for all[479]. Informatics has progressively become an important foundational competence along with the three Rs: reading, writing, and arithmetic/mathematics. For some time, most European educational systems fell behind this trend, focusing more on digital literacy and with the digitalisation of teaching[459]. The main limitation of this approach is that, despite providing pupils the means to *use* digital technologies, it does not fully equip them with the ability to *create, control and develop* digital contents.

Informatics has many names and a slightly different interpretation depending on the country. In the United States and in the UK there is a distinction between the concepts of Computer Science, the "scientific" part of the discipline including concepts such as computational structures, processes, algorithms, data structures and programming and the more technological side, called Information Technology. The European interpretation of informatics tends instead to comprise both 'the **science and technology of processing information**'[460].

As noted by the Committee on European Computing Education in 2017, in most European countries informatics was at most optional and offered to a limited subset of students, some of whom could complete secondary education without ever being exposed to its basic principles. However, some countries, like Bulgaria, Poland and Slovakia, have a long-standing tradition of teaching informatics in school, and there is a growing consensus on the importance to offer students a sound education in informatics[461]. Most European countries are implementing or developing curricular reforms to informatics teaching, often as part of the recovery and

[457] Eurostat Adult Education Survey and OECD (2021). Skills Outlook 2021: Learning for life.

[458] Transversal analysis of the 2020 Member States Reports on National Developments in Adult Learning and on the implementation of the Skills for Life flagship initiative.

[459] Committee on European Computing Education (2017). Informatics Education in Europe: Are we all in the same boat?

[460] Académie des sciences (2013). L'enseignement de l'informatique en France. Paris

[461] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Luxembourg: Publication Office of the European Union.

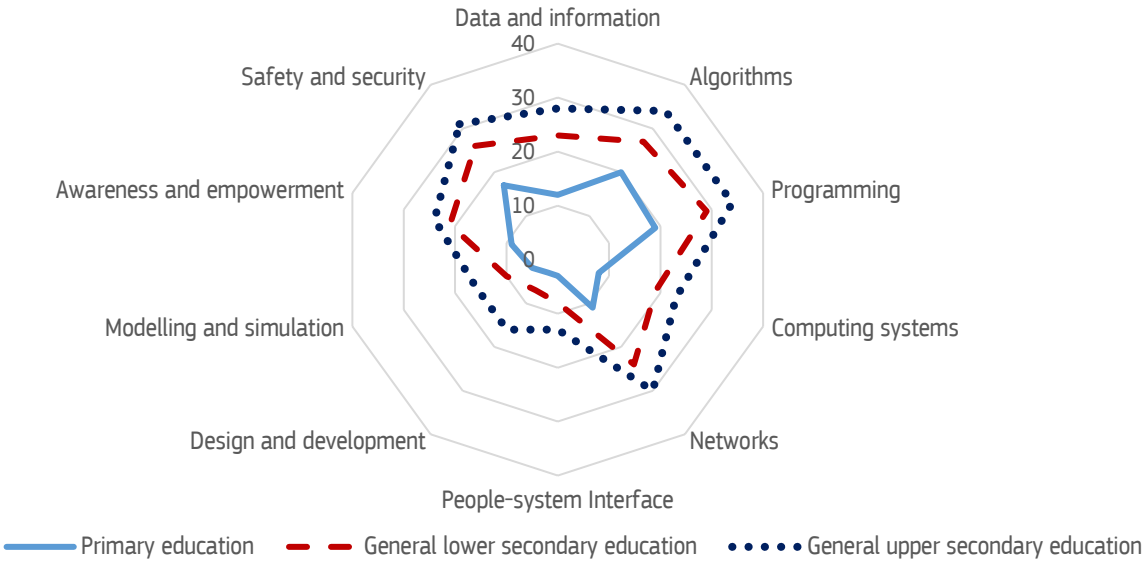
resilience plans developed in response to the COVID-19 pandemic[462]. 17 education system are in the process of implementing curricular reforms, and 11 others are planning the development of new digital strategies also addressing informatics.

Key competences and pedagogical approach

A 2022 Eurydice report on informatics education at school in Europe identifies **ten major competences** specifically connected to informatics[463]. These can be divided in more operational competences (data and information, algorithms, programming, modelling and simulation), systemic competences (computing systems, networks and communication) and ethical and anthropological competences (people-system interface, design and development, awareness and empowerment and safety and security)[464].

Data show that European formal education systems address an **increasing amount of competences at different educational levels** (either in mandatory or optional courses). With some exceptions like Greece, most countries introduce informatics in primary school with algorithms, programming and safety and security, while concepts like networks, computing systems and human-machine interface are usually left for secondary education.

Figure 16: Coverage of informatics-related areas by European education systems in primary and general secondary education, 2020/2021



Source: Eurydice

Similarly to what was presented for digital skills in general, informatics in school can be taught as a separate subject or integrated in another subject, usually related to science[483]. Informatics

[462] For more information on the Recovery and Resilience Facility (RRF), the main recovery instrument to mitigate the economic effects and social impact of the COVID-19 pandemic, see https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

[463] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Luxembourg: Publication Office of the European Union.

[464] Informatics for All coalition (2022). Informatics reference framework for school

plays an important role in other scientific subjects requiring data processing, such as physics, applied sciences and biology. On the one hand, **teaching informatics as a separate subject** allows to better define educational goals and it gives it a most prominent status, improving the synergy with other subjects. On the other hand, the main challenge is to find place for another subject in an already overcrowded timetable. When informatics is not a compulsory subject, moreover, there is the risk that it is perceived as a very technical and specialised topic and that stereotypical assumptions, such as the gender bias, are reinforced by this perspective.

The other possibility is to **integrate informatics into another subject**, so to more easily find it a place in the timetable. This would also favour a better integration of informatics with real-life case studies and examples. However, this might have negative repercussions on the content development during the school year and possibly on teacher's effectiveness and career. The "traditional" subject to which it is paired could take prevalence over informatics. Due to the more challenging scheduling process, informatics teachers could face difficulties in organising their teaching activities. Not being appointed a fully curricular subject, they could also be penalised in the progression of their career.

Informatics in formal education

Traditionally, as also confirmed by the Committee on European Computing Education[465], informatics in schools has been primarily reserved to upper secondary level, both in formal education and in vocational schools. Lately, a growing consensus started to emerge on **teaching informatics in primary education**, of course adapting the curricular activities to the learning capabilities of students of that age. Usually, this translates into putting a stronger emphasis on concrete and operational skills, leaving the more abstract concepts for later educational stages. Research show[466] that using a "**start early**" approach could lead to positive effects on the development of digital and beyond-digital (creative thinking, mathematical skills, reasoning) skills in young students. Starting early could also serve to reduce the gender bias by introducing the subject before the emergence of stereotypical assumptions on technical and scientific topics.

Making informatics a **compulsory subject** offer the possibility to all students to experience informatics, potentially increasing their interest in the discipline. This is especially important to address gender and any other bias. The main challenge of this approach is represented by the required specialisation of teachers, as pointed out by other international experiences[467], who should possess an adequate skillset even in lower educational stages. This poses challenges especially related to the re-skilling and upskilling of the existing teaching population in primary education.

Data show[468] that in Europe, only Greece and Lithuania have informatics as a compulsory separate subject from the beginning of primary education. A few other countries, such as

[465] Committee on European Computing Education (2017). Informatics Education in Europe: Are we all in the same boat?

[466] Scherer, R., Siddiq, F., & Sánchez Viveros, B. (2019). The cognitive benefits of learning computer programming: A meta-analysis of transfer effects. Journal of Educational Psychology

[467] The Royal Society (2017). After the reboot: computing education in UK schools.

[468] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Luxembourg: Publication Office of the European Union.

Poland, Latvia, Slovakia, Bulgaria and Hungary, have introduced compulsory informatics in the higher grades of primary school. Croatia and Slovenia were the only two countries in which it is optional at primary level. Seven other EU Member states include informatics in primary school, integrating it in another subject. Importantly, 16 education system do not offer informatics in primary school at all, but might include generic digital competences.

The situation is different at secondary level. In lower secondary education, all but 4 countries included in the Eurydice study offered informatics in their curricula, either as a separate subject or integrated into another subject. However, most Member States offer a combination of optional and mandatory teaching depending on the level. Whereas in lower secondary education the vast majority of educational systems mandates at least some form of informatics education, in upper secondary education it is largely optional or compulsory for only a subset of students (almost always as a dedicated subject).

Students progress during their learning process through various stages of development, which allow them to acquire competences of increasing sophistication. As for other subjects, this is true for informatics as well. For this reason, it is important to **fully integrate the educational process across all educational stages**, from primary to secondary school, up until higher education and adult learning, tailoring the educational strategies to the cognitive development stage reached by students. Informatics is both a science and a technique. Theory and practice are fundamentally connected, and working on practical application often represents the best way to get students interested in the underlying processes.

Addressing the gender and representation gaps in informatics

All learners in formal education should have the opportunity to develop advanced digital skills, irrespective of gender, ethnicity, social and economic level and disability. Special approaches, although still sporadic, are being taken to **engage female students** in developing more refined digital skills, with the aim to increase the share of women with advances studies and careers in ICT[469], and to reduce the gender imbalance in these subjects. As presented in section 2.1, recent research show that girls in primary and secondary education outperform or perform similarly to boys on digital skills, but show lower levels of self-efficacy[470], which prevents them from pursuing ICT studies in tertiary education[471]. This self-efficacy gender gap is also supported by results by the 2nd Survey of Schools: ICT in education, which showed that male students, compared to female students, feel slightly more confident in most digital competence areas, including problem solving, information and data literacy and safety.[472]

[469] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Eurydice Report. Luxembourg: Publications Office of the European Union.

[470] The 'self-efficacy' gender gap is the difference between girls' and boys' confidence and belief in their abilities. See: West M., Kraut R., Ei Chew H. (2019). I'd blush if I could: closing gender divides in digital skills through education. UNESCO.

[471] Gebhardt E., Thomson S., Ainley J., Hillman K. (2019). What Have We Learned About Gender Differences in ICT?. In: Gender Differences in Computer and Information Literacy. IEA Research for Education, vol 8. Springer, Cham.

[472] European Commission (2019). 2nd Survey of Schools: ICT in Education. Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

The long-standing issue of a **gender gap in STEM** disciplines has its origins in the lower presence of women in related academic degrees. The Informatics Europe Higher Education Data Portal[473] reports statistics from a sample of 18 European countries (15 EU Member States plus Switzerland, Turkey and the UK), showing that the percentage of **female students enrolled in the first year of informatics** bachelor degree programmes was **only 18.4%** in the 2019–2020 academic year. Although scarce and only available for the US, data on secondary education female students' participation in (optional) informatics courses paint a similar picture.

Educational systems, especially at primary and secondary level, might contribute significantly to address this issue. **Stereotypical assumptions** on the profile of informatics students (socially awkward and technology-focused males) have an impact on the social perception of specialised ICT students and workers, potentially steering away female perspective students. This is why the **first contact** of (female) students with informatics should **happen as soon as possible**, before prejudicial assumptions are interiorised and push underrepresented groups away. This is confirmed by a wide array of research[474].

EU Member States are introducing **provisions to increase female participation** in STEM and informatics in their education strategies. The approaches could be different, with some countries (e.g. Belgium) developing gender-based programmes focused on girls, while others (e.g. Estonia and Austria) opting for a more 'universal' approach.

Similar efforts should also be made to **identify territorially[475] and socioeconomically disadvantaged groups** (as for instance those living in rural areas, outermost regions and other remote areas, disadvantaged or marginalised groups such as Roma third-country nationals with limited knowledge of the host country, those having a low level of education, or not in education, employment or training), customise the provision accordingly, and set up supporting measures facilitating their equal participation.

Research[476] show that a lack of qualified teachers can represent an obstacle to equal access for students to advanced digital education. Teachers should be adequately prepared to deal with groups of students with diverse ethnicities, socioeconomic backgrounds and genders. In this respect, addressing the gender gap in digital skills between male and female teachers deserves special attention: the 2nd Survey of Schools: ICT in education[477], for instance, showed that male teachers report much higher self-stated confidence levels compared to female teachers

[473] Informatics in European in Higher Education

[474] European Commission/EACEA/Eurydice (2022). Informatics education at school in Europe. Luxembourg: Publication Office of the European Union.

[475] The Rural in Digital Scoreboard, developed under the EU Rural Action Plan, can be an useful instrument to find information in rural areas including on digital skills.

[476] Cateté V., Alvarez L., Isvik A., Milliken A., Hill M., and Barnes T. (2020). Aligning Theory and Practice in Teacher Professional Development for Computer Science. Proceedings of the 20th Koli Calling International Conference on Computing Education Research (Koli Calling '20). New York: Association for Computing Machinery..

[477] European Commission (2019). 2nd Survey of Schools: ICT in Education. Objective 1: Benchmark progress in ICT in schools. Luxembourg: Publications Office of the European Union.

across all five digital competence areas (i.e. digital content creation, problem solving, information and data literacy, communication and collaboration and safety).

Teachers in Informatics

Good quality teaching means that teachers need to be equipped both with **far-reaching knowledge** on the subject and with **appropriate pedagogical skills**. Since informatics is a relatively new subject in schools, it is likely that the **current teaching workforce never studied it** during their school and academic years. This means that re-training educators in informatics could be more complex to manage than with other disciplines.

Participants to the Stakeholder Consultations for the preparation of this initiative agreed that the availability of teachers with adequate preparation and qualification to teach informatics is a key element hindering the development of high-quality and inclusive pedagogical practices on informatics. They highlighted that the challenge is two-fold as there is a need to simultaneously focus on **training new teachers** and **reskilling/upskilling existing teachers** in a sustainable way. They called for additional efforts to better prepare generalist teachers on the matter (e.g. having digital skills is not enough to teach informatics), attract specialist informatics teachers, establish a culture of ongoing professional development, share teaching materials and resources that also need to be translated and localised.

Teacher retention and **attracting new specialists** into teaching informatics were also mentioned as key element to look at. The main challenge is represented by the fact that **ICT graduates are in high demand** in the job market, and there is a great deal of competition for schools. Salaries and careers opportunities in industry are generally more attractive than in the academia and (even more) in schools[478]. Participants to the stakeholder consultation confirmed the teaching staff shortage in this area[479] and suggested to experiment hybrid solutions and consider developing flexible learning pathways to train and recruit informatics graduates (some of whom might wish to teach part-time). In **primary education**, teachers tend to have a generalist training and to teach more than one subject. In almost all EU education systems in which informatics is included as a specific subject, generalist teachers can teach it. Only in Greece, Slovenia and partially in Bulgaria, specialist informatics teachers are required also in primary school. Moreover, to address teacher shortages, in some education system (e.g. Estonia) schools can recruit IT specialists without teaching qualification on a temporary basis. Specialist teachers go through dedicated training provided through initial teacher education (ITE) or retraining programmes. Usually, such training courses also include elements of pedagogy and psychology.

In **lower secondary education**, two thirds of education systems allow informatics teachers with specialisation other than informatics (usually mathematics, physics and other sciences). Only Hungary and Slovakia allow generalist teachers when no specialists are available, usually

[478] Informatics in European in Higher Education

[479] The same is confirmed also by sector's associations. For example, a 2022 study of the German Stifterverband mentions that Germany has a specialised informatics teaching workforce of 10000 people, but that it would need another 20000 to reach the same teaching level as its leading regions of Mecklenburg-Western Pomerania and Saxony. Source: https://www.stifterverband.org/sites/default/files/informatikunterricht_lueckenhaft_und_unterbesetzt.pdf

requesting additional training certifications. In all education systems in Europe[480], **specialist teachers go through dedicated training** provided through initial teacher education (ITE), retraining programmes for teachers or alternative pathways. Amongst the latter, the most common are **professional-oriented programmes** designed to supply candidates with non-teaching academic degree in informatics with the necessary skills to obtain a teaching qualification. Retraining programmes for teachers are part of continuing professional development (CPD), allowing teachers to extend their qualifications to also include informatics.

In **higher secondary education**, owning to the growing complexity of the curricula, half of education systems in Europe require informatics specialists, while the other half allow specialists in other disciplines (usually mathematics, sciences, engineering and economics) to deliver informatics curricula. Similarly to lower secondary education, qualifications to teach informatics in higher secondary schools exist in most EU Member State, either through ITE programmes, retraining of teachers or alternative training programmes.

For all educational levels, a fundamental need is the availability of **quality teaching materials** for informatics courses, focusing both on the content as well as on the pedagogical support to teachers and students. Data show[481] that in many Member States, countries are directly responsible for developing their teaching material, sometimes in collaboration with universities and private companies.

3.3 Structural challenges and emerging needs

The analysis in the previous sections focused on the specific issues of the different education levels. However important it is to look at characteristics in each level, it is also essential to maintain an overall vision of the whole educational path. From the analysis of the Structured Dialogue, **transversal** issues and lines of actions can be drawn:

- **Progression of digital skills across educational levels**. To be effective, digital skills should be offered in an integrated, coherent and progressive educational path going from early infancy to the adult life. Starting with more basic digital concepts at an early age, the level of sophistication and details of digital education should grow consistently with the development of cognitive capacities in students. Notwithstanding school autonomy and the different challenges that educational levels face, this requires clear policy guidance and an overall education strategy supporting coordination amongst pre-schools, schools, VET providers and universities. Shared criteria for assessment and certification of digital skills would support this process. Most Member States prepared educational strategies for digital skills, but only few considered a holistic approach throughout the various stages of education and training. The Structured Dialogue confirmed challenges especially in the implementation phase. Member States acknowledged the importance to build stronger links between levels of the formal

[480] With the exception of the German-speaking Community of Belgium.

[481] Informatics in European in Higher Education

education system and between formal and non-formal education systems with respect to digital skills development. They also highlighted that educational systems must ensure that curricular reforms and advancements in digital skills do not lag behind in compulsory schooling in comparison with VET and higher education.

- **Teachers' training**. One of the core aspects when it comes to providing quality education is to ensure that teachers possess all the skills they need to perform their job at best. In case of technical subjects, this might require specialist training and certifications. Across all educational levels, recruiting and properly preparing teaching staff[482] in informatics, ICT or other digital areas is a challenging effort, confirmed by stakeholders in the consultations organised in preparation of this initiative. The main reasons can be traced to the low availability of specialists in these fields and to the attractiveness of teaching when compared to a career in business, which usually offers better salaries and career development. At the same time, training and re-training of the existing teaching workforce is not enough to satisfy the needs, as confirmed by Member States in the Structured Dialogue. The offer of up-skilling and re-skilling initiatives for teachers is often not compulsory, and digital skills are seldom included in initial teacher training.
- **Monitoring, evaluation and assessment**. While most EU Member States have developed strategies for developing digital skills, few undertake regular monitoring and evaluation to assess their impact, review these strategies and put in place effective measures. To do so effectively, robust assessment tool of digital skills in students are needed. Organising unbiased, effective and on-point evaluation of any skills, and digital skills in particular, can be challenging for educational systems, schools and teachers. Its organisation requires clear strategic indication and guidance, and a proper analysis of the results. The Structured Dialogue suggests EU support would be beneficial in bridging this gap.

[482] The need to have adequately trained staff is not restricted to teachers only, but it can also include ICT coordinators and managing figures like headmasters.

ANNEX 1: PROCEDURAL INFORMATION

This Annex presents the procedural information concerning the preparation of the two proposals for Council Recommendations on the enabling factors for digital education and training and on improving the provision of digital skills in education and training. The two initiatives are distinct but complementary, and therefore accompanied by a single supporting Staff Working Document.

Leading Directorate-General: Directorate-General for Education, Youth, Sport and Culture (DG EAC)

Associated Directorates-General:

- Directorate-General for Communications Networks, Content and Technology (DG CNECT) → associated for PLAN/2021/11208: Proposal for Council Recommendation on the enabling factors for digital education and training
- Directorate-General for Employment, Social Affairs and Inclusion (DG EMPL) → associated for PLAN/2021/11209: Proposal for Council Recommendation on improving the provision of digital skills in education and training

The Staff Working Document has been written in close cooperation with the Unit T1 (Digital Economy) of the Joint Research Centre, which provided the thematic analysis of the Calls for Evidence, national Recovery and Resilience Plans and discussions from the Structured Dialogue on digital education and skills, which is presented in Annex 3.

Work Programme/Decide references: The two proposals for Council Recommendations were announced in the Communication 'Digital Education Action Plan 2021-2027: Resetting education and training for the digital age' (COM/2020/624 final), under actions 1 and 10, respectively. They were subsequently included in the Communication 'Making Europe Stronger Together' presenting the Commission Work Programme for 2022 (COM/2021/645 final), as non-legislative initiatives under the policy objective 'A Europe Fit for the Digital Age'. The Decide Planning references are PLAN/2021/11208 (proposal for Council Recommendation on the enabling factors for digital education and training) and PLAN/2021/11209 (proposal for Council Recommendation on improving the provision of digital skills in education and training).

Organisation and timing: The preparation of the initiatives started in September 2021 with the validation of the Decide Planning entries.

The preparation of the initiatives was formally accompanied by the Interservice Steering Group on digital education and skills, chaired by SG, and included representatives of the following DGs: EAC, CNECT, EMPL, AGRI, COMP, DIGIT, ECFIN, GROW, HOME, INTPA, JRC, JUST, LS, NEAR, REFORM, REGIO, RTD, SANTE, SG-RECOVER.

Three inter-service meetings took place chaired by SG:

- The first one, on 17 December 2021, had the objective to present and discuss the objectives and process of the Structured Dialogue with Member States on digital education and skills, which would constitute one of the sources of evidence for the initiatives. SG and the three core DGs (EAC, EMPL, CNECT) presented the planning and expected deliverables of the process, including the two proposals for Council Recommendations. 4 DGs (INTPA, AGRI, REGIO and DIGIT) took the floor to

provide support and feedback on the outlined plans. In addition, EAC provided an update on the progress of the implementation of the Digital Education Action Plan.

- The second inter-service meeting took place on 7 April 2022 with the objective to update services about the progress in implementing the Structured Dialogue and collect feedback on the Calls for Evidence for the proposals for Council Recommendations. Following the meeting, DGs were invited to send written comments on the Calls for Evidence by 13 April 2022. Comments were received from four DGs (AGRI, ECFIN, JRC, REFORM).

- The third inter-service meeting took place on 9 November 2022 with the objective to discuss the draft outlines of the two proposals for Council Recommendations, as well as provide an update on the progress and the next steps of the Structured Dialogue. Following a presentation by EAC, 14 DGs took the floor. They provided positive feedback on the outlines and some additional suggestions regarding the content and wording of the text. Following the meeting, DGs were invited to send written comments on the outlines by 16 November 2022. Contributions were received from 16 DGs (AGRI, CNECT, COMP, DIGIT, ECFIN, EMPL, HOME, INTPA, JRC, JUST, NEAR, REFORM, REGIO, RTD, SG-RECOVER, SG).

The final drafts of the proposals for Council Recommendations and their supporting Staff Working Document were scrutinised in linked inter-service consultations, which took place from 20 February until 17 March 2023.

Positive opinion on the Staff Working Document was given by all services, with written comments from 4 DGs (CNECT, ECFIN, ESTAT, SG).

Positive opinion on the Council Recommendation on enabling factors for successful digital education and training was given by all services, with written comments from 17 DGs (AGRI, CNECT, COMM, DEFIS, DGT-EDIT, DIGIT, ECFIN, EEAS, EMPL, FISMA, INTPA, JRC, JUST, REFORM, RTD, SG, SJ)

Positive opinion on the Council Recommendation on improving the provision of digital skills in education and training was given by all services, with written comments from 18 DGs (AGRI, CNECT, COMM, DEFIS, DGT-EDIT, DIGIT, EEAS, EMPL, ENER, FISMA, HOME, INTPA, JRC, JUST, REFORM, RTD, SG, SJ).

Evidence, sources and quality

Evidence presented in this Staff Working Document covered:

- Research reports, policy documents and academic literature published in the last two years, since the adoption of the Digital Education Action Plan 2021-2027.
- Targeted studies by European Expert Network on Economics of Education (EENEE), Eurydice, the Joint Research Centre, and the Organisation for Economic Co-operation and Development (OECD).
- Data from DESI, EURYDICE, EUROSTAT, ICILS, PIAAC, PISA, TALIS.
- Results of the open public consultation run in preparation of the Digital Education Action Plan 2021-2027.
- Feedback received in response to the Calls for Evidence for the two proposals for Council Recommendations.

- Results of 13 targeted stakeholder consultation events held in 2021-2022 and involving a wide range of stakeholders.
- An analysis of the findings from the bilateral deep-dive meetings with all 27 Member States organised as part of the Structured Dialogue on digital education and skills.
- An analysis of Member States' national Recovery and Resilience Plans.

A detailed description of the stakeholder consultation activities is provided in Annex 2. Literature and main sources are described in Annex 5.

ANNEX 2: STAKEHOLDER CONSULTATION SYNOPSIS REPORT

This synopsis report describes all stakeholder consultations conducted in preparation of two Commission proposals for a Council Recommendation, one on the enabling factors for successful digital education and training and one on improving the provision of digital skills in education and training. The activities carried out allowed the collection of stakeholders' views on:

- The COVID-19 crisis and its implications for digital education and skills;
- Key challenges in the development of high-performing digital education ecosystems and the enhancement of digital skills and competences for the digital transformation;
- Areas to be addressed in the two proposals for a Council Recommendation.

In addition, the evidence base benefits from in-depth discussions with policy makers in all 27 Member States in the context of the Structured Dialogue on digital education and skills, which are reported in Annex 3.

1. Consultation activities, context and consultation methodology

The stakeholder consultations were conducted in three ways:

- Open Public Consultation on the Digital Education Action Plan 2021-2027 (June - September 2020);
- Targeted stakeholder consultations (October 2021 - December 2022);
- Calls for Evidence for the two initiatives (August - September 2022).

1.1. Open Public Consultation on the Digital Education Action Plan 2021-2027

The Open Public Consultation (OPC), conducted in 2020 in preparation of the Digital Education Action Plan 2021-2027, had the objective of better understanding lessons from the COVID-19 pandemic and gathering views on how to best support education and training systems in the digital transformation. Given its objectives, its wide-ranging questions, and its recent deployment, the feedback received in the OPC remains relevant for the current initiatives.

The OPC was available in all EU languages and open to all citizens and organisations. The 2,716 replies, which included 136 input papers, came from 60 countries, with a good representation of the various sectors and levels of education. The collected data was analysed with quantitative and qualitative methods, including the DORIS tool[483]. A summary report providing a factual description of the OPC results was prepared by the Joint Research Centre (JRC), the European Commission's science and knowledge service, in cooperation with the Directorate-General for Education, Youth, Sport and Culture (DG EAC)[484].

[483] DORIS (Data Oriented Services) is a European Commission-tool created to analyse the qualitative data of public consultations by providing data analytics services. The tool features a Sentiment box which divides the responses into 'positive', 'neutral' and 'negative' sentiment with 81% accuracy. It also identifies key words, based on frequency.

[484] Summary report

1.2. Targeted stakeholder consultations

The targeted stakeholder consultations included events dedicated to one of the two proposals for a Council Recommendation and events with a combined focus. The target groups for consultation were identified on the basis of a stakeholder mapping that took into account geographical and sectorial coverage. In addition, both proposals were discussed in detail in dedicated meetings of the European Education Area Working Group on Digital Education: Learning Teaching and Assessment (DELTA), whose members include representatives of Ministries of Education from EU Member States, EFTA countries, EU candidate countries and education organisations.

In view of achieving wide participation and engagement, as well as complying with COVID-19 restrictions, video conferences, online workshops and panel discussions were the main channel used for consultation. The collected data was analysed using qualitative methods. Table 1 provides an overview of the stakeholder groups and the respective format and focus of each targeted consultation.

Table 2 - Overview of the targeted consultation activities

N.	Consultation Activity	Topic	Date	Stakeholders	Member States	CR
1	Online dedicated high-level panel discussion at the European Education Summit	Strategies for a successful digital education transformation	9 December 2021	Policymakers, practitioners and young people	All MS	Enabling factors
2	Online plenary meeting with the DELTA Working Group (Digital Education: Learning, Teaching and Assessment)	Enabling Factors and the Structured Dialogue on digital education and skills	26 January 2022	DELTA Working Group	All MS	Enabling factors
3	Online dedicated high-level panel discussion at the Digital Education Stakeholder Forum	Key enablers for digital education in Europe	22 March 2022	Policymakers, practitioners and young people	NA	Enabling factors
4	Online dedicated panel discussion at the Digital Education Stakeholder Forum	Digital Skills and Competences: Achieving the EU's goals together	22 March 2022	Policymakers, practitioners and young people	NA	Digital skills
5	Hybrid participatory workshop	Improving the Provision of Digital Skills in Europe: The Place of Informatics in School Education	6 April 2022	Experts and professors on informatics coming from different Member States	Virtually all MS	Digital skills
6	Online plenary meeting with the DELTA Working Group	Improving the provision of digital skills and competences	10 May 2022	DELTA Working Group	All MS	Digital skills
7	Online participatory workshop	Improving the Provision of Digital Skills in Europe: the Role of the Civil Society	13 May 2022	The Community of Practice of the Digital Competence Framework (DigComp)	NA	Digital skills

8	Online Peer Learning Activity (PLA) with the DELTA Working Group	Improving the provision of digital skills and competences	28-29 June	DELTA Working Group	All MS	Digital skills
9	Online participatory workshop	Improving the Digital Education and Skills in Europe: the Role of the Private Sector	1 July 2022	Members of Digital Europe and Giga Europe, and other major IT providers	NA	Enabling factors & digital skills
10	Online dedicated workshop at the European Week of Regions and Cities	Regional and local perspective on digital education and skills	12 October 2022	Policy makers from all levels of government, private companies, practitioners	All MS	Enabling factors
11	Online participatory workshop	Stakeholder Consultation for CR Proposals on 1) Enabling factors for digital education and 2) Improving the provision of digital skills in education and training	21 October 2022	Stakeholders from the formal, non-formal and informal education and training community, social partners.	NA	Enabling factors & digital skills
12	Online Peer Learning Activity (PLA) with the DELTA Working Group	Enabling factors for digital education	26-27 October 2022	DELTA Working Group	All MS	Enabling factors
13	Hybrid dedicated panel discussion at the Education Summit 2022	Empowered in the Digital Age: Effective Provision of 21st Century Digital Skills in Education and Training	1 December 2022	Policymakers, practitioners and young people	All MS	Digital skills

In addition to the 13 targeted consultations listed above, the proposal for a Council Recommendation on improving the provision of digital skills in education and training was a discussion item in the agenda of different meetings organised by the Directorate-General for Employment, Social Affairs and Inclusion (DG EMPL) and Directorate-General Communications Networks, Content and Technology (DG CNECT), including:

- Expert Group of EU Associations of VET providers[485] (22 March 2022)
- Working Group on Adult Learning[486] (31 March 2022)
- Advisory Committee on Vocational Training (ACVT)[487]/Directors General for Vocational Training (DGVT)/European Quality Assurance in Vocational Education and Training (EQAVET)[488] members (26 April and 8 December 2022).
- The Digital Assembly (21-22 June 2022).

[485] The expert group includes European Associations of VET Providers.

[486] Members include representatives from Member States' public authorities, Ministries of Education from third and candidate countries, trade unions and other organisations.

[487] Members include trade unions, business associations and other organisations, Member States' public authorities, as well as other public entities of third and candidate countries.

[488] The European Quality Assurance Reference Framework for Vocational Education and Training (EQAVET) supports the implementation of the 2020 recommendation on Vocational Education and Training for sustainable competitiveness, social fairness, and resilience. It includes National Quality Assurance Reference Points (NRPs) that bring together relevant stakeholders at the national and regional level. Together with national representatives from ministries and other responsible bodies, the NRPs are at the core of the European EQAVET network.

1.3. Calls for Evidence

The Calls for Evidence (CfE), one for each Council Recommendation, were open from 1 August to 16 September 2022. They outlined the political context, the problems the initiatives aim to tackle, their objectives and the need for EU action. The CfEs were available in all EU languages and resulted in 88 submissions on the enabling factors for successful digital education (including 42 input papers) and 95 submissions on improving the provision of digital skills in education and training (including 48 input papers). Both quantitative and qualitative methods were used to analyse the feedback. The analysis, carried out in cooperation with the JRC, included the following steps: topic identification, tagging, consistency review, descriptive statistical analysis, and qualitative content analysis.

2. Summary of the consultation results

2.1. Enabling factors for successful digital education and training

2.1.1. Open Public Consultation on the Digital Education Action Plan 2021-2027

The COVID-19 crisis created a sense of urgency with regards to digital education, with many stakeholders considering it as a 'turning point' for how technology is used in education and training. The OPC results revealed *socioeconomic inequalities* and *insufficient infrastructure* as the most prominent challenges for digital education in Europe. Infrastructure and connectivity were specifically mentioned as essential elements in the provision of digital education. The majority of respondents identified disparities in infrastructure and the availability of digital tools as the key challenges faced during the COVID-19 crisis. Issues related to connectivity and digital equipment were particularly relevant for educators, education and training staff, and representatives of education and training institutions.

One fifth of educators who responded to the public consultation (2020) reported that during the pandemic they had insufficient digital skills and competences. The *need to equip educators and teachers with digital competences* was recognised as the most important element in the provision of digital education, while *teacher training and guidance* prevailed as one of the most pressing challenges for digital education and also as an area where EU support is needed. In parallel, *supporting education and training institutions to develop digital education strategies* ranked third in terms of areas where the EU could bring added value, while the *lack of planning and vision for integrating digital technologies* was also classified as a significant challenge in Europe.

Finally, the provision of *high-quality online learning resources, including platforms and content*, was mentioned as another area where the EU could add value. The OPC results showed that for the majority of the respondents digital content is most useful when it is interactive and user-friendly. Overall, in view both of the crisis and the longer-term challenges of the digital transformation, stakeholders called for a *more strategic and consistent approach on digital education.*

2.1.2. Targeted stakeholder consultations

The following section presents an overview of the targeted stakeholder consultations on the enabling factors for successful digital education and training in four areas, namely 1) impact-

focused investment, 2) whole-of-government approach and involvement of stakeholders, 3) support to education and training institutions and staff, and 4) monitoring and evaluation of digital education and training policies - which correspond to the main topics discussed by stakeholders.

Impact-focused investment

Ensuring access to digital devices and developing capacity for their use were identified as fundamental areas for investments in digital education. As mentioned in the high-level panel of the Digital Education Stakeholder Forum, equal provision of digital equipment in schools is considered one of the most important elements for achieving equity and inclusion. Along the same line, it was highlighted in the high-level panel of the 2021 European Education Summit that connectivity should be treated as a public good and a call was made for a European approach that leaves no one behind.

The issues of *inclusion and accessibility* were also raised by some representatives of the WG DELTA, indicating that targeted evidence-based investments should be applied to vulnerable groups. Regarding assistive technologies, the group noted that there is a need for guidelines on their benefits, types and costs that could be used by practitioners. Additionally, reference was made by most of the consulted groups to the need for *appropriate digital content and tools*. Representatives of the formal education sector noted that digital education tools should be adaptive and flexible, and stressed the need for reliable digital education technology providers that are required to secure data protection and privacy. The consulted representatives of the private sector recognised the importance of promoting privacy and security in their products. Closely related to that, some panellists of the 2021 European Education Summit called for special attention to be given to ensuring digital wellbeing.

Some of the representatives of the WG DELTA raised the issue of *sustainability and maintenance of the digital equipment* and, by extension, the need to upgrade digital content to adapt to new technologies. Representatives of the private sector expressed similar views and further highlighted the importance of digitalisation in education being planned and implemented with a long-term perspective. Representatives of both the private and the formal education sector emphasised the importance of *continuity of reforms and investments* in digital education, with the latter group emphasising that investments should take *teachers' and learners' needs* into consideration.

Some of the consulted groups provided suggestions on *procurement processes for digital education*. In the EU Week of Regions and Cities workshop, the importance of empowering municipalities in managing investments in digital education and skills was emphasised, with representatives of Local and Regional Authorities suggesting that small-scale actions at local level could be more effective in responding to rapid technological advances. *Streamlining funding opportunities and making efficient use of EU funding* were seen as essential by the representatives of the private sector. Lastly, the representatives of the WG DELTA suggested that *public-private partnerships* would be beneficial in the area of connectivity, while some also called for more public initiatives that could compete with private technological solutions.

Whole-of-government approach and involvement of stakeholders

The need for an inclusive digital education and training ecosystem that ensures *cooperation at different levels* received wide recognition across all groups of stakeholders. More specifically, consulted groups shared the view that *the involvement of all stakeholders* is of paramount importance as achieving high quality digital education and training should be a common

endeavour across different bodies of the government, the private sector, civil society, social partners, etc. The WG DELTA representatives particularly highlighted that the cooperation with stakeholders needs to be continuous, from the decision-making processes to the implementation of digital education policies. In a similar vein, the representatives of the formal education sector suggested the establishment of structured dialogues at national level that would ensure the involvement of the different governmental bodies and other stakeholders and would reflect the wide range of needs and priorities.

Both the representatives of the WG DELTA and the formal education sector expressed some reservations about *cooperation with the private sector*. The former pointed out the need to prevent the risk of commercialising education and the latter raised the issue of ensuring transparency and data protection in the use of specific platforms. Representatives of the private sector called for greater dialogue and cooperation, while expressing concerns about how excessive centralisation of decision-making at national level can lead to difficulties in innovation and scaling-up projects.

Concerning the implementation of digital education policies, the significance of strengthening *local and regional leadership* as well as ensuring a proper coordination of the various EU policy programmes and support mechanisms was underlined in the high-level panel discussion of the 2021 European Education Summit. Both representatives of the private sector and the formal education sector called for a *holistic approach to digital education*, with the latter noting that it is important to have clear objectives at both national and European level, as well as a clear vision for digital education ensuring quality and inclusion in education in general - a view that was supported by the representatives of the WG DELTA.

Support to educational and training institutions and staff

The need *to provide opportunities for teachers to develop their digital skills* was recognised as particularly important throughout all consultations, and in most cases highlighted as a key priority. Representatives of the formal education sector emphasised the importance of offering support to educators in both Initial Teacher Education (ITE) and Continuous Professional Development (CPD) to enable them to purposefully and efficiently use digital technologies in their teaching practices. In this regard, they underlined the value of peer exchange and research on embedding digital skills in teacher education programmes.

The consulted groups suggested that, in addition to developing a training offer, authorities should find ways to *incentivise* teachers to undertake training on digital pedagogy and to use digital technologies in their daily practice. The lack of dedicated time for professional development was reported as a discouraging factor. The creation of communities of practice was identified as an effective way to provide support to teachers.

Representatives of the WG DELTA pointed out the need for further efforts and measures to *support education and training institutions*, including the provision of ICT coordinators and digital education mentors to schools. Furthermore, many members advocated for the use of *self-assessment tools*[489] (e.g. SELFIE) as a supporting measure to facilitate schools' digital transition, and highlighted the need to develop a whole-school approach to digital education, for example through the development of *digital strategies*. The representatives of the formal education sector called for support to *school leadership* (e.g. headmasters) to promote digital education and proposed the development of guidelines on digital pedagogy.

[489] Considering the limitations of self-assessment in the quality of evidence that it provides, the representatives of the WG DELTA suggested a combination of self-assessment with other types of monitoring/assessment.

Monitoring and evaluation of digital education and training policies

Systematic monitoring of the impact of policies and investments in digital education and training was viewed as a pressing area by the representatives of the WG DELTA, who reported that it was crucial to move beyond measuring outputs and instead focus on outcomes (i.e. impact of investments). They called for research in this area and argued for an evidence-based approach that applies both quantitative and qualitative methodologies. Aligned with this view, trade unions in the meeting with the Advisory Committee on Vocational Training mentioned the need to clearly define the desired impact of investments and the indicators to be measure it.

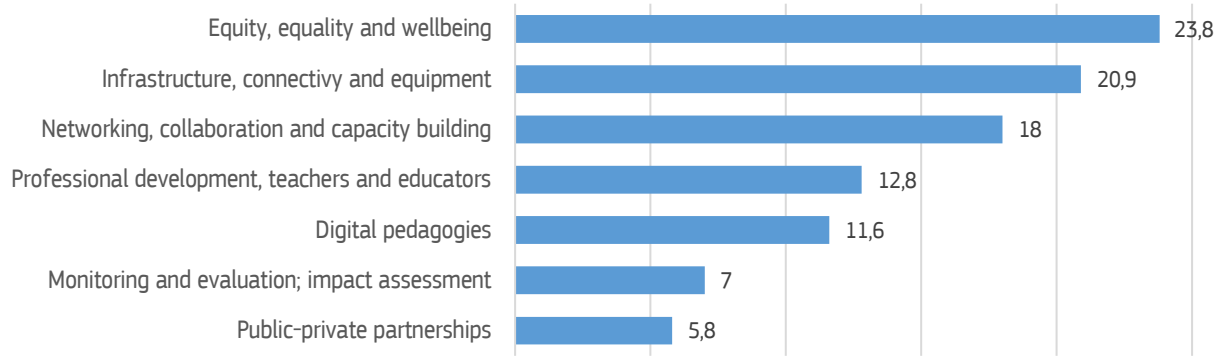
Considering the insufficiency of available evidence that would support the development of comprehensive monitoring and evaluation systems in digital education policy, the WG DELTA representatives stressed the need to conduct *more research* in the area of effective monitoring and develop appropriate indicators. The need for clear indicators was also expressed by representatives of the formal education sector, with some voicing concerns on the use of indicator-based evaluation in every aspect of digital education (i.e. alternative forms of assessment, including qualitative evaluations, should be considered depending on the information needed).

Finally, the need to encourage the *involvement of stakeholders* in the evaluation of digital education policies was emphasised by the representatives of the formal education sector and the panellists of the Digital Education Stakeholder Forum, underlining the importance of involving learners in the impact-assessment process to enable them to evaluate the quality of the education provided.

2.1.3. Call for Evidence[490]

The chart below shows the most frequent topics that emerged from the submissions to the CfE on the enabling factors for successful digital education and training.

Figure 1 - Frequency of topics covered in the feedback to the CfE on the enabling factors (%)



Equity, inclusion and wellbeing was particularly emphasised by non-profit and non-governmental organisations. Emphasis was placed on accessibility, while concerns were also expressed about the inclusion of disadvantaged students. A small amount of comments reflected the need to adopt rights-based or value-driven approaches that reflect diversity. The digital

[490] This section of Annex 2 has been written by using the analysis carried out by the JRC, in collaboration with the Directorate-General for Education, Youth, Sport and Culture.

wellbeing of students was another topic of concern, with many contributions revolving around the importance of raising young people's awareness and minimising the potential harmful effects of technology (e.g. cyber-addiction).

Infrastructure, connectivity and equipment is another area that received wide recognition. In particular, business associations and private companies as well as individuals placed a relatively high emphasis on this topic, calling for further investments and improvements in the digital infrastructure of education and training systems. Another emerging theme under this topic was concerns related to digital sovereignty, with contributions highlighting the importance of putting education needs ahead of industry needs. Submissions also highlighted issues of data protection and data privacy, where the concepts of "privacy by design" and "security by design" were advocated. These concepts tended to co-occur with interoperability concerns.

Regarding *networking, collaboration and capacity building*, an area that was mainly emphasised by public authorities and academic/research institutions, contributions advocated for the need to foster an effective collaboration among Member States. In addition, a small number of submissions commented on the need to promote more *public-private partnerships* and suggested ways on how these could enhance the digital education ecosystem. Concerns were expressed in a few instances about overreliance on digital platforms and tools that are privately rather than publicly financed.

Various submissions called for more efforts to recognise and support the central role of *teachers and educators* in the (digital) education ecosystem; a view that was strongly supported by trade unions. There were calls for more investment in teacher professional development and a few submissions suggested the need to encourage participation in teacher training, as well as recognition of it. A small number of contributions also noted the importance of including digital pedagogies as a core element of ITE. Lastly, some submissions reflected the view that professional development in digital pedagogies should be viewed through the broader lens of CPD more generally.

When it comes to *digital pedagogies*, submissions advocated for the use of digital tools only if they add value to teaching and learning practices. While some were enthusiastic about the potential of digital technologies to increase students' motivation, others expressed concern about the harmful effects of digital technologies and questioned the feasibility of a common EU approach on digital pedagogy.

Little contribution was provided on *monitoring*, with a few submissions indicating that monitoring could be more effective if integration and coherence within the digital education ecosystem are ensured, and some emphasising the need to monitor both effectiveness and inclusion aspects of digital education.

EU-level support was suggested in relation to interoperability, data privacy and data protection. Other themes emerging in this context included the suggestion to build on already existing research at EU-level, the development of an EU-wide repository of digital pedagogical content and a platform for digital education content, as well as encouragement for EU-level engagement with private players.

2.2. Improving the provision of digital skills in education and training

2.2.1. Open Public Consultation on the Digital Education Action Plan 2021-2027

The OPC results highlighted the need to *enhance digital competences* for the digital transformation, both in everyday life as well as for participation in the labour market. A large majority of respondents, both in personal and organisational capacity, shared the view that the pandemic and consequent switch to online learning and working increased the importance of digital skills and competences.

The majority of stakeholders self-assessed their skills or those of their staff *as sufficient to implement digital learning/working or support their children* in this area (around 84% in both). Still, the need of digital skills during the crisis was seen as unmet by around a fifth of the respondents. Two thirds of the respondents reported that they *had improved their skills in their personal capacity during the crisis* and many took specific steps to do so. Additionally, more than a half planned to *improve their digital skills and competences in the future.* Among the groups replying in organisational capacity, the vast majority shared that their organisation or institution had taken steps to improve the skills of their staff and that the digital skills of the staff had improved during the crisis. A large part of the respondents from this group also shared that their organisation planned to improve the skills of the staff in the future.

Concerning the *different types of digital skills and competences*, skills related to digital and media literacy and data privacy were considered among the most important skills for living and working in the 21st century. In contrast, understanding new and emerging technologies was not considered a pressing aspect by the respondents.

There was also a call from stakeholders (umbrella organisations, formal education and private sector) to focus at European level on high-quality *computing, informatics and technology education* as a way to promote better understanding of the digital world. Higher education institutions and research centres on informatics as well as organisations representing IT professionals also asked for integrating the subject across curricula at all education levels and identifying a respective framework of high-quality informatics.

2.2.2. Targeted Stakeholder Consultations

The following section presents an overview of the targeted stakeholder consultations on improving the provision of digital skills in education and training in four areas, namely 1) Curricular approaches to teaching and learning digital skills, 2) Assessment and certification, 3) Specialist teachers and teacher training, and 4) Cross-sectorial cooperation and funding - which correspond to the main topics discussed by stakeholders.

Curricular approaches to teaching and learning digital skills

The *importance of digital skills* was echoed in all stakeholder consultations, in particular as a key element for a successful digital and green transition in society and the economy. In the 2022 Education Summit panel, a specific point was made on the importance of *intergenerational learning* and encouraging different generations to learn from and with each other. The panel also stressed the importance of distinguishing between *digital skills and digital habits* and the need to focus on developing these good habits instead of only skills.

Stakeholders across all consultations agreed that the provision of digital skills needs to be strengthen by adopting a *holistic and lifelong learning approach*. Member States underlined

the importance of digital skills for personal and professional development and VET providers and trade unions added that adults should embrace this perspective and continue learning basic digital skills as well as critical thinking and other key competences.

The WG DELTA stressed the *importance of starting from an early age* which could reduce gender gaps, stereotypes and technophobia. However, representatives from the formal education sector underlined that *different pedagogical approaches* are needed for different age groups, especially when it comes to very early age. In addition, representatives of the WG DELTA noted that digital skills should follow a gradual progression from basic to advanced digital skills, but that the focus should always be on making students *digitally competent citizens*. Stakeholders agreed on the need to ensure a good basis to everyone but also promote a deeper understating and independent use of digital technologies. They called on the need to keep working and strengthen the cross-curricular or transversal approach, but also stressed the need to build and share expertise on how to teach and assess digital skills as a specific subject across the different levels of education.

Across stakeholders there is a growing consensus on the role that *informatics* can play in promoting a deeper understanding and more conscious and active use of technology. However, there was no consensus among stakeholders on the best approach to integrate informatics into existing curricula. The WG DELTA noted that the options for a dedicated subject or integration of informatics transversally across existing courses have both pros and cons. They mentioned that a cross-curricular approach could help to develop student's skills in a comprehensive way, but could potentially dilute the focus and importance of digital skills, making it difficult to adequately cover all necessary aspects. With regards to the introduction of informatics, or more generally digital skills, as a separate subject (compulsory or elective), they stressed that this comes with its own challenges. In their view, national curricula are already overstretched, making it challenging to introduce a new subject without reducing or taking out other subjects. In addition, the content of a separate subject would need to be relevant and supported by specialised teachers. In the discussion, they recognised that at the primary level, a combination of approaches is commonly adopted, while at the secondary level, disciplinary specialisation becomes more prominent, but is not always offered to all students equally.

In the panel of the Education Summit and Digital Education Stakeholder Forum the concept of *digital idols and role models* was introduced as key to motivate the new generation. Panellists argued that children can only aspire to what they know exist and that schools should therefore promote these role models in ICT. Stakeholders of the formal education sector suggested that curricula could be further strengthened by engaging different stakeholders, for instance external experts that can support bridging the gap in specific competences. Experts from the informatics community argued that curricula should include a *compulsory number of hours in informatics* for all students to strengthen the value of the discipline.

Inclusivity is another topic upon which stakeholders from multiple sectors shared their views. Experts of the informatics sector underlined the need for a coherent narrative to promote a common understanding on the role of informatics and better communicate its value. Stakeholders from the informatics community, the WG DELTA and, more generally, the education and training sector also underlined that there are many terms used in the area of digital skills and informatics without clear distinction, sometimes carrying negative connotation. A suggestion was that a common European reference framework could help in developing common language and meaningful pedagogical practices. Stakeholders from multiple sectors argued that the narrative should consider the gender dimension (a curriculum that is equally

attractive to boys and girls) as well as work towards addressing other inequalities (age gap, rural/urban divide, marginalised groups).

To clearly map the digital skills gaps, stakeholders from the private sector stated that there is a *need for more specialised surveys* that focus solely on digital skills instead of integrating the topic into larger cross-national surveys (e.g. PISA). Boosting digital skills of different segments of the population means identifying different areas that require targeted interventions.

Assessment and certification

Stakeholders across all consultations named improving *assessment and certification* of digital skills as a significant factor in the provision of digital skills.

The life-long learning perspective is especially relevant in digital skills as the continuous technical development makes it necessary to keep skills up to date. For the recognition of skills, multiple stakeholders called for *micro-credential and non-formal education* to be part of official accreditation. Furthermore, representatives from the private sector argued that assessment and certification should also be improved in VET education.

The DigComp community of practice highlighted the importance of certification and noted that *cooperation between the third sector and the formal education and training sector* can help to formalise skills and competences and help deploy targeted measures to specific learning needs. The WG DELTA noted that *exchange of good practices regarding digital skills assessment* should be encouraged. To ensure the well-being of students, there was also a call for diversity in the forms of assessment.

Private sector stakeholders noted that in companies people are usually seen as a cost and stressed the need for fostering a change in this regard e.g. by showing the value of investing in upskilling employees and its return of investment.

Specialist teachers and teacher training

The importance of specialist teachers and teacher training was a reoccurring topic in all stakeholder consultations, especially when discussing the value of informatics for digital skills development. Experts from the informatics community highlighted that *availability of teachers* that are trained on informatics is a key element hindering the development of high quality and inclusive pedagogical practices. They noted that the challenge is two-fold as there needs to be simultaneous focus on *training new teachers* while also *reskill/upskill existing teachers*. This was also recognised by the WG DELTA whose members underlined that Member States face both a difficulty in finding general teachers with the necessary expertise as well as a lack of specialist teachers. They noted that not only the recruitment is challenging, but also teacher retention as the competences needed to teach informatics are highly sought after in the private sector, which offers better salary and career opportunities. A possible solution that was offered was the development of flexible learning pathways to train and recruit informatics graduates.

Representatives of the private sector suggested that the sector could contribute to effective teacher training by providing input into forecasting future skills needs, as well as contributing to the teaching of advanced digital skills.

Cross-sectorial cooperation and funding

Together with a holistic and lifelong learning approach to the development of digital skills, stakeholders also expressed the need to *increase cooperation* between different sectors and

stakeholders. In particular, the need for more cooperation with the formal education sector was seen as a beneficial future development by both the private sector and the third sector.

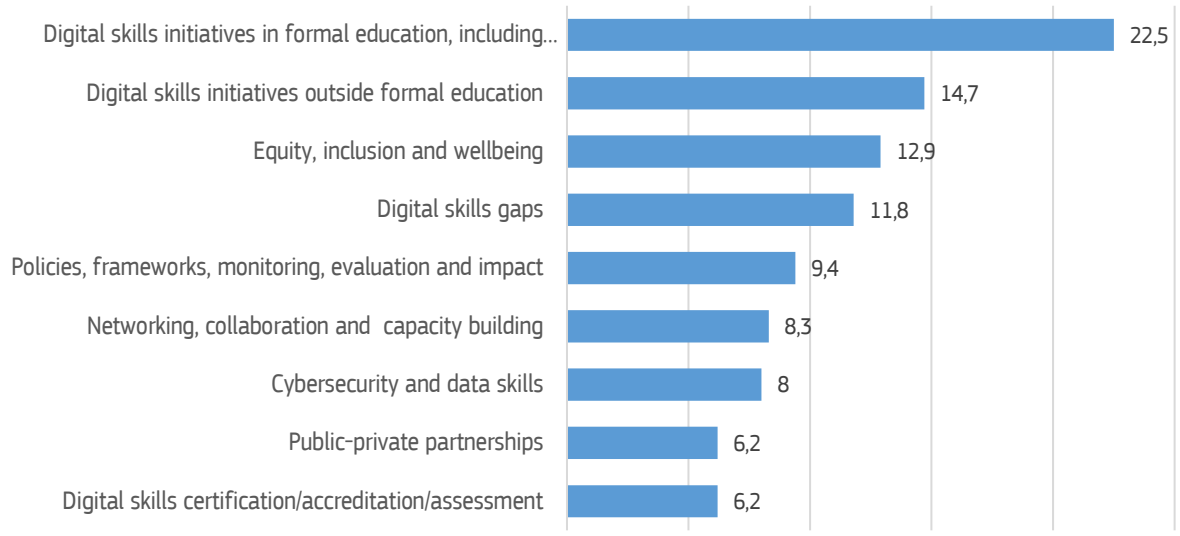
Stakeholders mentioned that the private sector has a vested interest in investing in the training of the population as they have a need for skilled workers. They also noted that private companies can support in tailoring the provision of digital skills to the needs of the labour market and make it more effective. The third sector can help in expanding the target groups and engaging those that are hard to reach both geographically and socially.

Across all consulted groups, stakeholders mentioned the importance of *dedicating more funding* to the provision of digital skills, with particular focus on projects that are based on strong cross-sectorial cooperation. Experts from the informatics community noted that more funding should be directed towards future *research on effective and impactful curricula, pedagogical practices and materials on informatics.* They also noted that the EU should provide and fund opportunities to experiment and evaluate existing initiatives in the view of sharing them across Member States. The WG DELTA advocated for more funding for schools to help with the aforementioned teacher recruitment issue.

2.2.3. Call for Evidence[491]

The chart below shows the most frequent topics that emerged from the submissions to the CfE on improving the provision of digital skills in education and training.

Figure 2 - Frequency of topics covered in the feedback to the CfE on the enabling factors (%)



On the topic of *digital skills in formal education*, mentioned mostly by academic/research institutions and trade unions, submissions emphasised a holistic and learner-centred approach to digital skills. Provision of digital skills should be age-appropriate and adapted to individual needs. Digital skills of teachers need to be continuously updated, recognised and supported by peer learning. Concerning curricular content and reforms, contributions recognised that digital

[491] This section of Annex 2 has been written by using the analysis carried out by the JRC, in collaboration with the Directorate-General for Education, Youth, Sport and Culture.

skills teaching and learning should be a core part of the curricula from an early age (lower primary), alongside other core skill development. They also highlighted the importance of teaching and learning informatics from primary school level and the need to modernise curricula across sectors, while aligning them between sectors and Member States. Specifically for higher education, there were calls to promote cutting-edge digital skills provision and research, as well as multi- and inter-disciplinarity.

The topic *digital skills outside of formal education* was mostly emphasised by trade unions. Submissions on this topic highlighted the need to adapt digital skills training to the needs of individuals, professions, sectors and specific groups. Content should include more modularity and flexibility. There were also calls for an increase in training offer and awareness-raising among enterprises and SMEs, and calls to leverage existing EU funding and collaborations to support the existing provision. Further suggestions were made to foster synergies between formal and non-formal education.

The topic of *equity, inclusion and wellbeing* was mostly mentioned by non-profit or non-governmental organisations and individual citizens. Submissions that prioritised a single group most commonly referred to women, followed by disadvantaged/vulnerable groups and individuals with disabilities. Some submissions argued that the digital divide is part of a broader social and systemic problem, while others suggested that exchange on best practices for achieving digital inclusion across Member States should be encouraged. A concern was raised that the 80% digital skills target for adults could exacerbate the existing digital divide. It was suggested that sub-targets for specific groups should be included and monitored.

Submissions to the topic of *digital skills gaps*, which was mostly emphasised by professional associations, commented that a range of interventions is needed to address the digital skills gaps, that there is a need to boost digital skills in the workforce, and that both digital and soft skills should be fostered. Submissions mostly underlined the importance of a holistic approach and inclusivity. Moreover, contributions highlighted the potential in partnerships between education and the private sector to focus recruitment on a 'hire-and-train' approach for ICT specialists. Submissions mentioned the shortage of ICT specialists, noting that closing the gender gap in ICT professions would help. According to stakeholders, there is also a need to upskill and reskill employees in specific sectors (e.g. healthcare, social care).

On the less frequent topics, submissions emphasised the need for *monitoring and evaluation.* Some of the submissions referred to data and evidence gaps, including with regards to skills forecasting, monitoring training offer and teacher training effectiveness. In addition, submissions underlined the need for *coordination across actors in a range of ways*. Strengthening cooperation would help to achieve a coherent and systemic approach to the provision of digital skills inside and outside of formal education settings. Submissions were generally positive toward *public-private partnerships* and highlighted the importance of cybersecurity, data literacy and data management skills and their embedding in overall digital skills development. They also expressed a positive view on the benefits of *certification/accreditation and assessment* and advocated for a unified approach across Member States.

3. Conclusion

3.1. Enabling factors for successful digital education and training

The provision of *digital infrastructure, connectivity and equipment* was considered as essential across the different consultations. The OPC results showed that insufficient infrastructure continues to be one of the most considerable challenges for digital education in Europe, while calls for further investments ensuring access to digital devices for all and enhancing the digital education ecosystem in general were also present throughout the targeted stakeholder consultations and the submissions to the CfE.

The need for *support and training for teachers* was another particularly important topic highlighted in all consultations, including incentivising teachers to take up training opportunities.

Collaboration was equally seen as an important aspect, encouraging the exchange of good practices among Member States. Particular reference to the involvement of all stakeholders and cooperation at different government levels was made in the targeted stakeholder consultations.

The need for *monitoring* digital education policies was strongly supported in the targeted stakeholder consultations, particularly underlining the importance of monitoring impact, rather than outputs.

3.2. Improving the provision of digital skills in education and training

All consulted stakeholders stressed the importance for people of all ages to be digitally skilled. There was an equally strong consensus on the *need to strengthen the provision of digital skills* to make it more effective and to connect to the learning needs of different target groups. The OPC results, the targeted stakeholder consultations, and the CfE submissions show that this is something stakeholders recognised in both personal and professional capacity as well as during and after the COVID crisis.

Across the different consultations, stakeholders acknowledged the *need for curricular reforms* and the role that *informatics* can play either as a separate subject or as part of a cross-curricular approach. Both targeted stakeholder consultations and CfE submissions recognised that digital skills teaching and learning should be a core part of the curricula from an early age and that attention should be put on the learning progression.

All different consultations also expressed the need to build and share expertise on *how to teach and assess digital skills as a specific subject* across the different levels of education. The need for equity, inclusivity and working towards closing the different digital skills gaps, was reflected in the targeted stakeholder consultations and the CfE submissions, while being of lower priority in the OPC.

Stakeholders acknowledged the unavailability of *specialised and digitally competent teachers* as the problem that stifles further developments and emphasised the importance of continuous teacher training. They also acknowledged the value of *increased cooperation* between sectors and the importance of *certification/accreditation and assessment*.

ANNEX 3: THEMATIC ANALYSIS IN SUPPORT OF THE STAFF WORKING DOCUMENT

Annex 3 of the Staff Working Document is constituted by the following JRC report with a thematic analysis of the Member States' Recovery and Resilience Plans, meetings of the Structured Dialogue on digital education and skills, and submissions to the Calls for Evidence for the two Council Recommendations.

Annex 3

Thematic analysis in support of the Staff Working Document for Council Recommendations:

Improving the provision of digital skills in education and training, and

Digital education – enabling factors for success

Submitted February, 2023

Cosgrove, J., Tsotsou, I., Cachia, R., Centeno, C., Sala, A., Punie, Y.

Joint Research Centre

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Contents

Abstract

The overall objective of the analyses is to provide input to the Staff Working Document (SWD) accompanying the Council Recommendation proposals on the enabling factors for successful digital education ('enabling factors') and on improving the provision of digital skills in education and training ('digital skills'). The report describes emerging themes specific to the upcoming proposals for Council Recommendations from Member States' Recovery and Resilience National Plans; the European Commission's Structured Dialogue meetings with Member States; and submissions and position papers received in response to the Call for Evidence concerning the two Council Recommendation proposals.

The aims of the analysis are to provide a cross-country synthesis of the current and emerging themes and trends on enabling factors for successful digital education, and on the provision of digital skills in education and training; identify and describe key challenges, barriers and concerns in each of these two areas; and propose a set of policy implications.

Two groups of enabling factors emerged from the analysis. These are (1) foundational enabling factors (infrastructure, connectivity and equipment; digital content, tools and platforms; networking/collaborative supports/activities; and Initial Teacher Education (ITE) and Continuing Professional Development (CPD) for digital pedagogy); and (2) enabling factors that provide direction, structure and value for successful digital education (equity, inclusion and wellbeing; monitoring, evaluation and assessment; research and data; and opportunity and innovation).

Similarly, two groups of digital skills provision topics emerged from the analysis. These are (1) direct-impact initiatives and actions (digital skills initiatives in education settings; digital skills initiatives outside of education settings; ITE and CPD for digital skills; and equity, inclusion and wellbeing-related digital skills initiatives); and (2) indirect-impact initiatives and actions (monitoring, evaluation and assessment; research and data; and opportunity or innovation).

Findings indicate a high degree of consistency between the key themes emerging from the Recovery and Resilience Facility (RRF) national plans and Structured Dialogue. The submissions to the Call for Evidence featured some aspects of digital skills (e.g. cybersecurity skills, digital skills certification) to a somewhat greater degree than the other sources of information, most likely due to differing perspectives of the stakeholders involved.

Two major priorities of current efforts include investments in infrastructure, connectivity and equipment; and initiatives to boost digital skills outside of formal education settings. The Structured Dialogue allowed for the identification of challenges that are being experienced across a majority of Member States. These included whole-of-government implementation of digital education and skills strategies; monitoring, evaluation and assessment; ICT specialists shortages; matching digital skills supply and demand; the assessment of digital skills; curricular reform; teacher supply; tackling the digital divide; and increasing the share of females in ICT-related education and occupations.

The concluding section summarises the priorities as described by Member State authorities with respect to both enabling factors for digital education and the provision of digital skills, and provides a set of 10 implications arising from the findings.

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Executive summary

Policy context

The overall objective of the analyses presented in this report is to provide input to the Staff Working Document (SWD) accompanying the Council Recommendation proposals on the enabling factors for successful digital education and on improving the provision of digital skills in education and training.

The scope of this report is to describe emerging themes specifically for the upcoming proposals for Council Recommendations from:

- Member States' (MS) Recovery and Resilience Facility (RRF) National Plans;
- Structured Dialogue meetings with MS; and
- Submissions and position papers received in response to the Call for Evidence (CfE) in respect of the two Council Recommendation proposals.

The aims of the analysis are to:

1. Provide a cross-country synthesis of the current and emerging themes and trends on enabling factors for successful digital education, and on the provision of digital skills in education and training;
2. Identify and describe key challenges, barriers and concerns in each of these two areas;
3. Propose a set of policy implications for consideration in the SWD accompanying the two upcoming Council Recommendation proposals.

Methods

Definitions

For the purposes of this analysis:

- **Enabling factors** concern ecosystems required for the development of high-quality and inclusive digital education. They focus on formal education and training, and cover: approaches taken by governments; investments in connectivity, infrastructure and equipment; provision of digital solutions, content and support; measures addressing teaching staff, educators, and institution leaders; the involvement of social partners and other stakeholders in policy; and the monitoring and evaluation of digital education policies.
- **Digital skills** are concerned with the provision of digital skills in education and training. They include reforms for digital skills (both general and specialist or sector-specific) and reskilling and upskilling initiatives in both formal and non-formal education.

Sources used in the analysis

The **Resilience and Recovery Facility (RRF)** is a temporary recovery instrument to support MS in implementing reforms and investments that are in line with the EU's priorities and that address the challenges identified in country-specific recommendations under the European Semester framework of economic and social policy coordination[492]. The European Commission's (EC) Recovery and Resilience Facility website hosts the national RRF plans for each MS. The sections of these plans that relate to digital education and skills have been included in the present analyses.

The **Structured Dialogue (SD)** is a process of exchange regarding digital education and skills between the EC and MS which ran during 2022. The objective of the dialogue is to support MS in the digital transformation of their education and training systems in an integrated, coherent and more ambitious approach[493].

[492] See https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en and https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/index.html?lang=en

[493] The dialogue was conceived and implemented in a transversal whole-of-government approach, co-ordinated in the EC by Secretariat-General (SG) and implemented in close cooperation by Directorate Generals (DGs) Education and Culture (EAC), Communications Networks, Content and Technology (CNECT), and

The discussions in the dialogue were structured according to five pillars:

- Pillar 1: Impact-focused investment
- Pillar 2: The place of digital competence in education and training systems
- Pillar 3: Governance of digital education, training and skills policies
- Pillar 4: The role of industry, social partners and other stakeholders
- Pillar 5: Contents of digital competence frameworks – advanced digital skills in the labour force.

The Structured Dialogue documentation used in the analysis comprised:

- presentations prepared by each Member State
- notes and minutes of discussions during the Structured Dialogue meetings
- publicly available information and evidence on the state of play regarding digital education and skills at the national level from a range of sources.

The EC launched two **Calls for Evidence (CfE)** (corresponding to each of the Council Recommendation areas) which ran from August 1 to September 16, 2022.[494] Submissions were received from 21 of 27 MS (18 MS submitted on enabling factors, and 19 submitted on digital skills). In all, 88 submissions were received for enabling factors (with 42 of these accompanied by a paper) and 95 submissions were received on digital skills (48 of these with papers).

Steps in the analysis

The following steps were applied to the analysis: topic identification; tagging; consistency review; descriptive statistical analysis; and qualitative content analysis.

Main topics emerging

Main topics emerging were:

- **Enabling factors:** digital content, tools and platforms; equity, inclusion and wellbeing; governance, engagement and partnerships; initial and continuing professional development in digital pedagogies; monitoring, evaluation and assessment; networking and collaborative supports and activities; opportunity and innovation; and research and data.
- **Digital skills:** equity, inclusion and wellbeing; initial and continuing professional development in digital skills; initiatives to boost digital skills outside of formal education settings; initiatives to boost digital skills in formal education settings (including curriculum reforms); monitoring, evaluation and assessment; opportunity and innovation; and research and data.

In addition, the Structured Dialogue provides information on the main **challenges** faced among MS and what **EU-level supports** may help with these.

Main findings: Enabling factors for digital education ecosystems

Two groups of enabling factors emerged from the analysis. These are

- **foundational enabling factors** – infrastructure, connectivity and equipment; digital content, tools and platforms; networking/collaborative supports/activities; and Initial Teacher Education (ITE) and Continuing Professional Development (CPD) for digital pedagogy; and
- enabling factors that provide **direction, structure and value for successful digital education** – equity, inclusion and wellbeing; monitoring, evaluation and assessment; research and data; and opportunity and innovation.

Employment, Social Affairs and Inclusion (EMPL), with support from the Recovery and Resilience Task Force (SG RECOVER) and the DG for Economic and Financial Affairs (ECFIN).

494 Available here https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13207-Digital-education-enabling-factors-for-success_en and here https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13208-Digital-skills-improving-their-provision_en.

Findings from RRF national plans with respect to enabling factors

A major focus of enabling factors within RRF national plans was on investment in infrastructure, connectivity and equipment. This topic featured in plans of 23 MS, most commonly in formal education settings but also referring to high-speed broadband connectivity projects and to a lesser extent, cybersecurity and cloud infrastructure.

Investments relating to digital platforms, content and solutions also featured strongly (in plans of 18 MS) and were mainly targeted to formal education settings but also included investments in business and public sectors. Emerging themes, particularly in Vocational Education and Training (VET) and Higher Education, were flexible, personalised and self-directed learning, and solutions to support blended and hybrid teaching and learning. These investments and reforms are accompanied by education and skills training offers.

Networking or collaborative supports or activities were identified in the RRF national plans of seven MS. These were again mainly targeted at formal education (e.g. new IT support structures; centres of excellence; multi-stakeholder partnership structures), while a small number referred to the establishment of innovation hubs or competence centres in the public services and business sectors.

Reforms or investments which referred to ITE and CPD for digital pedagogy featured in nine MS. Two-thirds of investments were targeted at primary and secondary education. The remaining one-third was evenly divided across VET and Higher Education settings.

Reforms and investments which explicitly featured monitoring, evaluation and assessment of enabling factors were identified in just five MS and referred to measures to monitor digital education strategies, operating at various levels of the system (e.g. national or institutional levels). Similarly, reforms and investments featuring innovation were identified in just seven MS (which tended to be among those with robust existing digital education ecosystems) and related to investments in Research, Development and Innovation (RDI) ecosystems or the deployment of emerging and advanced digital technologies in settings both inside and outside of formal education. Research on enabling factors was identified in reforms or investments in six MS. These were mainly targeted at Higher Education and national research communities.

Three key observations can be made:

- There is very little emphasis on monitoring, evaluation or impact assessment. While it may be the case that monitoring, evaluation and impact assessment are built into existing MS policy implementation, the RRF national plans did not routinely build in references to these activities to assess the efficiency and effectiveness of major investments and reforms.
- Some RRF national plans made explicit provision for enabling factors relating to disadvantaged or vulnerable groups, but the monitoring of investments and reforms in this regard is less clear.
- References to investments in infrastructure, connectivity and equipment are more frequent than references to other foundational enabling factors, i.e. digital content, platforms and tools; and CPD and ITE in digital pedagogies. Of course, it may be the case that investments in these latter areas are funded by other national or European sources, and a positive outcome of the SD is that it provides more information on these various elements of enabling factors.

Findings from the Structured Dialogue with respect to enabling factors

Infrastructure, connectivity and equipment are being prioritised across a large majority of MS. Emerging trends, building on the learnings of the pandemic were that: large-scale investment in devices is taking place; there is ongoing, substantial investment in improving connectivity; and specific measures targeted at disadvantaged learners in formal education settings commonly include the provision of free devices. There are variations within MS in levels of connectivity/coverage. Two main challenges emerged with respect to infrastructure, connectivity and equipment: a majority of MS do not yet have systems to track the use of digital equipment in education settings; and a few MS expressed concerns about the maintenance of connectivity, equipment and devices (in terms of lack of human resources to provide technical support and maintenance to schools, refurbishment/recycling, and in obtaining Finance Ministry support for investment in connectivity for schools).

MS are making significant efforts to support their digital education ecosystems through a range of digital content, tools and platforms, many building on work that began with the onset of the pandemic. An emerging

trend is the development of integrated platforms that provide educators and students with a single entry point. Three key concerns were raised in the SD discussions: challenges for schools and other educational institutions to meet General Data Protection Regulation (GDPR) obligations; complex interoperability and legacy platform system challenges; and matching the pace of technological change with updated teaching and learning content and tools.

Almost all MS described implementing multiple networking and collaborative initiatives to support an enabling ecosystem for digital education. An emerging trend is a dedicated digital education support role for schools, includes both technical support and maintenance as well as digital pedagogy and strategic planning elements.

Many MS are in the process of implementing CPD on a large scale, building on the learnings from the pandemic, and frequently combining both digital skills training for educators with enhancing their digital pedagogical competences. Some gaps are apparent: while participation in CPD is monitored in a majority of MS, there was much less focus on its impact. CPD programmes for education leaders were mentioned in some SD discussions but were less widespread than CPD for teachers, and the focus on CPD generally was at the primary and secondary levels rather than VET and Higher Education. Further, in some SD discussions, it was felt that solutions were needed to address low or varied teacher motivation to engage in CPD and to strengthen digital leadership in school management. Where ITE was discussed, most indicated that ITE included a mandatory component on digital pedagogies. Challenges in relation to ITE and CPD were discussed in 17 SD meetings, frequently in relation to the broader issue of teacher supply. Some MS commented on a perceived mismatch between the training offer and the needs of educators. This could be exacerbated by the fact that many MS do not currently have a fully-developed system to assess or monitor teachers' skills and skills needs (although several MS reported positively on the EC's self-assessment tools for schools and educators, SELFIE and SELFIEforTEACHERS). It was noted that Higher Education Institutions (HEIs), the primary source of ITE courses, are relatively autonomous.

Just over half of MS (14) expressed concerns about the digital divide (in particular in reaching vulnerable groups), recognising it as an issue with multiple causes and manifestations. MS authorities expressed a need for more support in effectively designing targeted investments to foster equity and equality in digital education, as well as in monitoring the impact and effectiveness of such efforts.

While all MS expressed an awareness of the importance of monitoring, evaluating and assessing enabling factors, MS are at different stages of doing so: monitoring systems are well-developed in only a small number of MS, while many have a fragmented or ad-hoc approach to monitoring. It was common for MS to describe challenges in achieving an integrated and systematic approach to monitoring the digital education ecosystem.

A clear emerging trend is the adoption by a large number of MS of whole-of-government approaches to digital education and digital skills policy development and implementation. However, a majority of MS found these co-ordination efforts challenging across government departments, across levels of government (e.g. national-regional), and with different stakeholders, particularly at the implementation and monitoring phases. Many MS have multiple national strategy and policy documents relating to digital education, which could be both a symptom and a cause of challenges in implementing whole-of-government approaches.

Another emerging trend was the recent increase in EdTech activities, and many MS officials recognised the potential of working with the EdTech industry to further improve or enhance digital educational infrastructure, tools and content. Concern or uncertainty was expressed in some SD meetings in relation to managing regulatory and data privacy aspects of the EdTech industry and/or the influence that EdTech may have on education systems.

Key areas for which advice or support from the EU is needed were: research and gathering of evidence in relation to enabling factors; funding supports for infrastructure and connectivity; and technical and operational advice or support concerning data privacy, interoperability of digital education platforms, and updating of (digital) pedagogical content and tools.

MS also sought more opportunities to exchange best practices with one another in a range of areas including reaching remote and vulnerable groups; engaging educators in CPD; digital content and solutions for digital pedagogies; the use of digital education tools and frameworks such as SELFIE and DigComp; models for the provision of technical support to schools; and sharing of solutions to technical challenges (e.g. interoperability).

The SD discussions included calls for the European Commission (EC) to strengthen its co-ordination and regulatory activities in a range areas, including awareness-raising and use of common language/terminology and standards in digital education; further alignment and connections of various initiatives within and across EU institutions; stimulation of partnerships between EdTech and public sector organisations; regulation of the EdTech industry; regulations and support concerning interoperability; monitoring Higher Education digitalisation strategies; data privacy policy consolidation; and alignment in the use of the European Digital Competence framework (DigComp). MS representatives also sought ways to improve networking between EU countries on enabling factors themes and priorities.

Findings from the submissions to the Call for Evidence with respect to enabling factors

There was significant emphasis on equity, inclusion and wellbeing in the submissions, many of which advocated a rights-based or value-driven approach that reflects diversity. There was also an emphasis on accessibility, and concerns were expressed about the digital wellbeing of students.

Infrastructure and connectivity were widely recognised as important, with calls for both improvements and further investments in this area. There was also some commentary on data protection, where the notions of privacy by design and security by design were advocated, and these concepts tended to coincide with interoperability concerns.

EU-level support was sought in relation to interoperability, data privacy and data protection, educational data standardisation, and engagement with private actors in the digital education system. There were also suggestions that the EU could support recognition of non-formal learning, along with suggestions for EU-wide platforms and digital repositories.

Regarding collaboration and partnerships, the submissions indicated broad support for the fostering of public-private partnerships, and collaboration between education and industry was broadly endorsed. However, some concern was expressed about the influence of 'tech giants' in the education system.

Regarding the professional development of teachers and educators, the centrality of teachers' roles was emphasised, and thus the importance of supporting teachers in their work. A few submissions recommended incentivising CPD and making it feasible for teachers to attend, e.g. during work hours. In commenting on digital pedagogies, the submissions took a holistic and learner-centred perspective, advocating the use of digital tools only if they add value, and not substituting or reducing existing resources with digital.

The submissions also suggested that monitoring could be more effective within an integrated and coherent digital education ecosystem, with some emphasising the need to monitor both effectiveness and inclusion aspects of digital education.

Main findings: Digital skills provision

Two groups of digital skills provision topics emerged from the analysis:

- **direct-impact** initiatives and actions (digital skills initiatives in education settings; digital skills initiatives outside of education settings; ITE and CPD for digital skills; and equity, inclusion and wellbeing-related digital skills initiatives); and
- **indirect-impact** initiatives and actions (monitoring, evaluation and assessment; research and data; and opportunity or innovation).

Findings from RRF national plans with respect to digital skills

Digital skills provision outside formal education was the topic with the highest frequency of investments and reforms (across 21 MS). A majority of reforms in this respect were targeted at the labour market, and one-quarter or so consisted of descriptions of the development or implementation of broad national plans or strategies. About a quarter of the investments which featured in this topic were broad in nature, describing the provision of digital skills training within an overall lifelong learning approach, tending to offer a mixture of basic and more advanced or specific digital skills training, and often mentioning digital inclusion among their aims. Around one-third of the investments were targeted at the labour market, where two trends emerged: reskilling and upskilling for workers in vulnerable or evolving occupational sectors; and forward-focused skills

provision on emerging technologies and/or green and digital skills combined. A further quarter were targeted at business (particularly small and medium-sized enterprises - SMEs) and industry, and all consisted of specific or advanced digital skills training. The remaining 10% of investments which featured digital skills training outside of formal education were targeted at government employees.

With respect to digital skills provision in formal education settings, reforms were identified in 18 MS and were reasonably evenly divided across primary and secondary education; VET; Higher Education; and reforms that cut across both formal and non-formal education settings. Curricular reforms at primary and secondary levels were identified in nine MS. A little over half of investments were targeted at Higher Education, covering a range of actions. In about half of the investments in Higher Education, collaboration with industry and/or international actors was a prominent feature. Roughly one in three investments was targeted at primary and/or secondary education, and just two of these investments made explicit reference to curricular reforms.

Reforms which featured equity, inclusion and wellbeing were identified in 10 MS. A common feature was the enhancement of existing programmes. About two-fifths of the investments featuring this topic sit within a broader social and digital inclusion agenda, where the focus was on the provision of basic digital skills training to specific groups. The remaining three-fifths of investments are located within broader active labour market skilling activities and a majority of these combine provision of basic, advanced and/or sector-specific digital skills training targeted at individuals not in employment, education or training.

Reforms and investments that featured ITE and CPD for digital skills were identified in just six MS. Half of the reforms were targeted at primary and secondary levels of the education system and refer both to digital skills and digital pedagogical skills training, while the other half made reference to digital skills development of educators in Higher Education and VET. A majority of the investments featuring this topic were targeted at primary and secondary education and related to CPD (rather than ITE) for digital skills development to support curricular reform or investments in infrastructure and platforms. The remainder of the investments featuring this topic were targeted at Higher Education.

Reforms and investments featuring monitoring, evaluation and assessment were identified in seven MS and covered a range of themes including the establishment of quality standards and/or monitoring arrangements in VET systems; enhancements to skills mismatch monitoring; digital skills accreditation; and evaluations of proposed digital skills initiatives.

Investments featuring opportunity and innovation were identified in nine MS, which tended to have strong existing digital education and skills ecosystems. Investments and reforms featuring research and data were identified in the RRF national reports of seven MS and these MS again tended to be among those with robust digital education and skills ecosystems.

Four key observations are that:

- As with the analysis of enabling factors there was not extensive reference to monitoring, evaluation or assessment activities. Again, the monitoring of planned investments, particularly with respect to digital and social inclusion, may merit attention.
- There is little emphasis on reforms or investments in digital skills assessment, either inside or outside of the formal education system.
- Some MS are implementing broad reform programmes that cover both formal and non-formal education, while others tend to treat formal and non-formal education separately.
- A comparison of reforms and investments targeted at compulsory education with Higher Education, VET, and non-formal education contexts suggests that the pace of curricular reform implementation at primary and secondary education levels is lagging behind implementation of digital skills provision initiatives at other levels of the system.

Findings from the Structured Dialogue with respect to digital skills

Consistent with the RRF analysis, digital skills initiatives outside of formal education settings was the most frequently referenced topic in the SD discussions. The focus was on delivering training to the desired group(s) rather than on monitoring the outcomes and impacts of these initiatives. In a majority of MS, digital skills training offerings were perceived to be insufficient to meet current needs, both for general training and for ICT specialists, with some tension between investing in advanced digital skills and digital skills for all. A majority of MS expressed concerns about the shortage of ICT specialists. Some MS reported that engaging adults in

digital skills training was challenging. Upskilling and reskilling of SME employees was seen to be more of a challenge in MS where large percentages of the workforce were employed in SMEs.

Recent and current curricular reforms were referenced by about two-thirds of MS. There is considerable variation across MS in the positioning of digital skills in national curricula and, overall, a low emphasis on the assessment of learners' digital skills. There is an emerging trend to teach digital competence both transversally and as a separate subject. There is also an emergence of teaching and learning informatics at upper primary and/or lower secondary levels, commonly as a separate, core subject.

In Higher Education, there is more of a focus on the development of programmes to teach specialist and advanced digital skills than on general digital skills, although about half of MS reported implementing combined skills programmes (generalist-specialist). A strong emerging theme in the VET sector is a focus on aligning and reforming VET curricula to labour market demand, with digital skills playing a major role in these efforts. To tackle the ICT skills shortage, MS are implementing a variety of initiatives in Higher Education and VET, including more course places, and/or shorter or more flexible courses, many of these supported by microcredentials development. Many MS sought solutions to the labour market 'pull' on ICT students and identified competition between these courses and those for ICT teachers. Some MS are implementing ICT profession visa schemes and/or schemes to attract students from overseas as part of their efforts to tackle ICT specialist shortages.

Several MS reported difficulties in achieving sustained engagement of teachers and educators in CPD (which is exacerbated by teacher shortages in several MS); implementing and assessing learning targets in a transversal approach; and various challenges associated with curricular reform. The widespread concerns about the insufficient number of ICT graduates was viewed in some of the SD meetings as an opportunity to further prioritise bringing more women into the profession.

A clear trend in the provision of CPD and ITE in digital skills is the widespread use of online training at a large scale, building on the experiences of the pandemic. The general trend in ITE is towards the inclusion of digital skills as a core part of preparatory courses. The link between the digital skills acquired during ITE and how to sustain this with CPD was absent from SD discussions, and the discussions did not provide much information on the expected impacts of teacher professional development. In MS where CPD was optional, there were more challenges in engaging the teaching profession, and the training offer tended to be more fragmented.

One of the two dominant themes in equity and inclusion aspects of digital skills provision was women in ICT. Various initiatives were described, but these tended not to be accompanied by information on their impact, and systematic and comprehensive programmes were not widespread. The second theme was digital inclusion, which covered a range of targeted skilling, reskilling and upskilling initiatives. However, it was not commonplace for MS to refer specifically to individuals with disabilities or special educational needs. A key challenge in equitable provision of digital skills raised during the SD discussions is the level of human resources required to engage meaningfully at local levels with the target communities.

Monitoring and evaluation of digital skills provision was, consistent with enabling factors, viewed as generally challenging. Several trends in this area emerged from the SD discussions: skills accreditation in VET; developing the use of microcredentials in Higher Education and VET; and interest in digital skills certification. Challenges in this area, in addition to those already identified under enabling factors, related to scaling up successful initiatives; complexity in developing microcredentials and digital skills certifications; measurement and monitoring of teachers' digital skills; accurate digital skills forecasting; and general complexities associated with impact assessment.

Research and data in relation to digital skills provision were concentrated in the employment sector, where a range of data sources and methodologies were being implemented for forecasting. The key challenge in this area was the timely availability of appropriate data for digital skills forecasting. Regarding innovation, many MS referenced digital innovation hubs, and several are implementing initiatives to promote AI skills or other emerging and advanced technologies, often through the creation of new partnerships (for example across education institutions and between education and industry sectors).

Suggestions for support at the EU level were provided by 21 MS. A majority sought further opportunities to exchange learning and good practices in a range of areas, including engaging with hard-to-reach groups;

increasing the share of women in ICT; developing data-driven policies; responding to rapidly evolving skills needs; and guidance on the development of public-private partnerships.

MS also sought further opportunities for exchange with the EC and/or efforts on the part of the EC to support the co-ordination of activities of MS in a range of areas. These included the co-ordination of efforts to address digital skills gaps; support for multi-country projects on digital skills provision; evaluation of digitalisation and digital skills provision initiatives; clarity in the relationships between the various EU-level digital skills bodies, initiatives, and funding instruments; technical and operational support for the adoption and monitoring of digital skills microcredentials; support for awareness-raising on digital skills, in particular among employer groups; support for the implementation of impact assessment; and strategies to tackle the gender gap in ICT.

To support their efforts, MS also requested support at the EU level for the development of (objective, psychometrically sound) digital assessment tools for general and specific populations; tools for the monitoring and evaluation of digital skills provision, and also provided suggestions for further development of digital skills frameworks. MS called for further research and analysis in two areas, specifically: supply and demand forecasting of digital skills, and digital skills provision mapping across formal and non-formal education and training systems.

Findings from the submissions to the Call for Evidence with respect to digital skills

A unifying theme of strengthening co-operation and co-ordination was evident across the submissions, with the objective of a coherent and systematic approach to the provision of digital skills across formal and non-formal education settings.

The main themes that emerged with respect to digital skills education and training outside of formal education were the recognition of a need to adapt digital skills training offer content to the needs of individuals and specific groups; the importance of digital skills provision alongside other core skills including problem-solving and soft skills; calls for more of a focus on the needs of SMEs; calls to leverage existing EU funding and collaboration structures to support provision; and various suggestions to foster links between formal and non-formal education settings.

The submissions emphasised a holistic and learner-centred approach to digital skills in formal education settings. The central role of the teacher in fostering digital skills of learners was acknowledged, and concerns were expressed about the need to create an appropriate and sustainable system for supporting the continued upskilling of teachers in this regard. Some submissions called for teacher digital skills upskilling in specific areas including AI and data analytics.

Commonly held views on curricular content and reform were that digital skills teaching and learning should be a core part of curricula from an early age; there is a need to modernise primary and secondary curricula; and that more collaboration is needed between HEIs and industry actors to support curricular reform; many submissions also recognised the importance of teaching and learning informatics from an early age. Consistent with commentary on digital skills provision outside of formal education settings, the commentary on provision within formal education expressed the view that digital skills occur alongside, and should be reinforced by, the acquisition of other core skills.

Commentary on equity, inclusion and wellbeing tended to reference or prioritise digital skills provision for specific groups. It was suggested that 2030 targets for specific groups should be developed and monitored.

Where views about public-private partnerships were expressed in the submissions, these were unanimously positive, and the main focus of this commentary was on the potential benefits of collaboration and partnership between the education sector and industry to meet skills provision needs. Similarly, positive views were expressed with respect to both digital skills certification and the use of microcredentials.

Submissions which mentioned frameworks (mainly DigComp) were favourable towards them and it was suggested to refine and revise the definition of basic skills as well as to develop specific digital skills profiles.

Regarding digital skills gaps, it was suggested that there is a need to foster digital skills in emerging and advanced technologies as well as in specialist areas; it was noted that ICT specialist skills can be taught and learned on the job, and as a result, recruitment practices should be broadened to include 'hire-and-train'; and that there is potential in partnerships between education and industry to achieve these aims.

Key conclusions

Transversal

- It is recommended that the EC continues to support the gathering and sharing of information and evidence on initiatives to tackle the digital divide, and that consideration is given to setting training participation, outcome and impact targets with respect to digital skills for specific priority groups at EU level.
- It is recommended that the EC supports the gathering of evidence to understand the barriers to female education and employment in ICT fields of study and occupations as well as to support the sharing of good, evidence-based practices to increase the share of girls and women in ICT-related education and employment.

Enabling factors for digital education ecosystems

- It is recommended that the EC supports the identification and sharing of good practices of MS on whole-of-government approaches across a diversity of contexts.
- It is recommended that the EC supports research on enabling factors for digital education and works with MS to address some challenges and data gaps in relation to the monitoring and evaluation of enabling factors for digital education, including information gaps on education system digital infrastructure and device usage.
- It is recommended to reinforce the importance of CPD for both teachers and school leaders in the relevant EU Working Groups, and to consider studies on: (i) the emerging challenges and needs of teachers and school leaders and how these might be addressed, and on (ii) a review and identification of strategies to tackle the shortage in teacher supply. It is further recommended that the EC supports MS to identify ways in which evaluation and impact assessment may be incorporated into CPD ecosystems.
- It is recommended that the EC supports MS exchanges concerning their experiences with respect to the digital co-ordinator role for schools in order to ensure that strategic and pedagogical support needs for digital education, as well as technical maintenance and support needs, are met. One possible way to support this could be through the establishment of a network or Community of Practice of digital education co-ordinators on the Digital Education Hub.

Digital skills provision

- It is recommended that the EC works with MS to address some challenges and data gaps in relation to the monitoring and evaluation of digital skills provision, in particular in relation to: data on training offer, on the outcomes and impacts of training, and for short and longer-term digital skills supply and demand forecasting.
- It is recommended that the EC supports research on the availability of digital initiatives for groups with disabilities and with special educational needs in order to identify any needs for specific digital skills actions.
- It is recommended that the EC supports MS exchanges on curricular reform and assessment issues, particularly with respect to transversal, separate-subject and mixed approaches, views on informatics as a separate subject, and the role of assessment in these various scenarios. It would also be important to gain a better understanding at the EU level of the needs and priorities of MS with respect to the assessment of digital skills in formal and non-formal education settings. Further collaboration with international organisations involved in the implementation of large-scale international assessments (such as ICILS, PIAAC and PISA) may be helpful in this regard.
- It is recommended that the EC further explore with MS the potential of public-private partnerships for addressing the most acute digital skills needs, and consider regulatory and data privacy aspects of these partnerships.

Caveats in interpreting the analyses

- In **general**, the analysis is a thematic cross-country synthesis, and should not be considered as providing a comprehensive factual overview of the situation across MS.
- The **RRF analysis** indicates areas of planned reforms and investments up until 2026; future implementation might not always be in line with current information. Furthermore, the analysis is based on the national recovery and resilience plans as published by the national authorities. In case

of discrepancies, the analysis is made without prejudice to the final version of reforms and investments to be financed under the Recovery and Resilience Facility, as adopted by the Council in Council Implementing Decisions. Analysis focuses on the content of proposed reforms and investments rather than on the magnitude of financial investments. The thematic analysis is done using a methodology separate from the 'official' ones (climate and digital tagging; pillar tagging). Results are not published at MS level, only in aggregate. RRF national plans vary in that some grouped many actions under a single sub-component, while others took a more granular approach. MS taking a more granular approach will have contributed relatively more to the overall picture than MS taking a less granular approach.

- The **structured dialogue** meetings with MS were guided by the five pillars as well as areas in which MS and the EC shared interest and concern, and areas for which the Commission would have liked to learn more about. Therefore, the overall frequencies of topic instances should not be interpreted solely as the relative level of priority given to them.

Quick guide

Section 1 provides the context, value and purpose of the report; **Section 2** describes aims, methods and caveats; **Sections 3** and **4** present findings relating, respectively, to enabling factors and the provision of digital skills in education. Each opens with the results of the RRF analysis, followed by the results from the SD analysis, then the topics and themes emerging from the CfE submissions; finally, **Section 5** provides conclusions and policy implications.

1 Introduction

Digital education and skills, and enabling factors that support this ecosystem, are the subject of a considerable body of existing research and evidence. The Digital Education Action Plan 2021-2027, adopted in September 2020[495], sets out a common vision of high-quality, inclusive and accessible digital education in Europe, and aims to support the adaptation of the education and training systems of Member States (MS) to the digital age.

The two strategic priorities of the Action Plan (fostering the development of a high-performing digital education ecosystem, and enhancing digital skills and competences for the digital transformation) have been put sharply in focus with the onset of the COVID-19 pandemic. The Action Plan was endorsed in the Conclusions on digital education in Europe's knowledge societies, where MS invited the European Commission (EC) to launch a strategic reflection process on the enabling factors of successful digital education. In her 2021 State of the Union address, EC President von de Leyen called for leaders' attention and a structured dialogue on these themes.

Following President von der Leyen's call, the EC launched the SD process with MS on digital education and skills. This dialogue aimed to increase the political visibility and commitments on digital education and skills, so that Europe may deliver on the ambitious targets set out for 2030. The outcomes of the Dialogue were also intended to feed into future actions at EU level on digital education and skills, including proposals for two Council Recommendations – on enabling factors for digital education, and on improving the provision of digital skills in education and training.

The two proposed Council Recommendations respectively address the two strategic priorities of the Digital Education Action Plan, putting forward two complementary but distinctive lines:

- The Council Recommendation on enabling factors for digital education will aim to ensure that European education and training systems are resilient and future-proof, by building political consensus on the preconditions and enablers of successful and effective digital education ecosystems, common to all sectors of education and training.
- The Council Recommendation on the provision of digital skills is centred on the steps and instructional methods for promoting the development of digital skills from early on and at all stages of education and training (primary, secondary and tertiary including VET and adult learning). It has a specific focus on the role of informatics in expanding the digital skills base. It also aims at raising the technical capacity of MS to achieve the Digital Compass targets on basic and advanced digital skills.

1.1 Purpose of the report

The overall objective of the analyses presented in this report is to provide input for the Staff Working Document (SWD) accompanying the Council Recommendation proposals on the enabling factors for successful digital education and on improving the provision of digital skills in education and training.

The EC publishes a range of evidence and indicators in relation to digital education and skills. These are a combination of regular (e.g. annual) reports based on Europe-wide data collection programmes and periodic, themed research publications. They include:

- The Digital Economy and Society Index (DESI) of Eurostat
- The Digital component of the Resilience Dashboard
- The annual Education and Training Monitor (ETM)
- The Structural indicators for monitoring education and training systems in Europe of Eurydice
- Comparative reviews of digital education by Eurydice, notably reports on digital education (2019) and informatics education (2019)

[495] The Digital Education Action Plan 2021-2027 builds on the previous Digital Education Action Plan (2018-2020).

- Work on skills shortages and skills mismatches by CEDEFOP such as its analysis of the European Skills and Jobs Survey (ESJS) (2022)
- Secondary analysis and insight from large-scale comparative surveys and assessments, such as the International Computer and Information Literacy Study (ICILS) and the Programme for International Student Assessment (PISA), and
- Research publications of the JRC on a variety of topics, including supporting policies to address the digital skills gap (2022) impact of COVID-19 on education (2020); evidence on innovative assessment (2019), and key principles for and features of effective digital education policies[496].

The results of the present thematic analyses do not describe or 'profile' individual MS, but rather present a cross-country synthesis. They are intended to add to the evidence base, as they reflect current views and emerging trends among MS policymakers, practitioners and stakeholders. This will allow for the identification of prominent and pressing themes which may be prioritised in current and forthcoming policies, actions, investments and reforms.

The scope of this report is to describe emerging themes specific for the upcoming proposals for Council Recommendations from:

- Member States' Recovery and Resilience National Plans;
- Structured Dialogue meetings with Member States; and
- Submissions and position papers received in response to the Call for Evidence (CfE) in respect of the two Council Recommendation proposals.

1.2 Structure of the report

This **Section 1** provides a brief overview of the context, added value, and purpose of the report.

Section 2 describes the aims and methods used in the analyses, including caveats that should be borne in mind when interpreting the findings.

Section 3 and **Section 4** present findings relating, respectively, to enabling factors for successful digital education and to improving the provision of digital skills in education and training. Each of these sections opens with the results of the RRF analysis, followed by the results from the SD analysis, then the topics and themes emerging from the CfE submissions.

Section 5 draws the main themes of the analysis together to provide conclusions and policy implications, organised into three sections: enabling factors for successful digital education; improving the provision of digital skills in education and training; and transversal or cross-cutting themes.

[496] The Staff Working Document SWD(2020)209 (*Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions; Digital Education action Plan 2021-2027: Resetting education and training for the digital age*) provides background on some main sources of existing evidence in these areas.

2 Aims, Method and Caveats

This section describes the aims of the study as well as the methods used, including descriptions of the Recovery and Resilience Facility (RRF) national plans, Structured Dialogue (SD) processes, and submissions to the Calls for Evidence (CfE). Definitions of the two Council Recommendation areas, as applied in the analysis, are also given. Then, the approach to the analysis is described. Finally, we outline some caveats or limitations which should be borne in mind when interpreting the results of the analyses.

2.1 Aims

The aims of the analysis are to:

1. Provide a cross-country synthesis of the current and emerging themes and trends on enabling factors for successful digital education, and on the provision of digital skills in education and training
2. Identify and describe key challenges, barriers and concerns in each of these two areas
3. Propose a set of policy implications for consideration in the SWD accompanying the two upcoming Council Recommendation proposals.

2.2 Methods

This section first describes what themes are covered under the two Council Recommendation areas within this thematic analysis. Then, the 'input' to the analysis, namely the documentation and processes associated with the RRF national reports, SD meeting documentation, and submissions to the CfE are described.

2.2.1 Definitions

The basis for these definitions lies in the EU Digital Education Action Plan 2021-2027, where the two high-level priorities are:

- **Priority 1:** Fostering the development of a high-performing digital education ecosystem
- **Priority 2:** Enhancing digital skills and competences for the digital transformation.

For convenience we use the terms 'enabling factors' and 'digital skills' in this report to refer to the two Council Recommendation areas.

For the purposes of this analysis:

- **Enabling factors** concern ecosystems required for the development of high-quality and inclusive digital education. They focus on formal education and training, and cover the approaches taken by governments, investments in connectivity, equipment, provision of digital solutions, content and support, measures addressing teaching staff, educators, institution leaders, the involvement of social partners and other stakeholders in policy, and the monitoring and evaluation of digital education policies.
- **Digital skills** are concerned with the provision of digital skills in education and training. They include reforms for digital skills (both general and specialist or sector-specific) and reskilling and upskilling initiatives in both formal and non-formal education.

In Sections 3 and 4 (on enabling factors and digital skills, respectively), the above definitions are expanded on further through the descriptions of the specific topics which emerged.

2.2.2 Recovery and Resilience Facility (RRF) national plans

The RRF is a temporary recovery instrument to support MS in implementing reforms and investments that are in line with the EU's priorities and that address the challenges identified in country-specific recommendations

under the European Semester framework of economic and social policy coordination[497]. It supports climate neutrality (2050) targets and enables digital transition.

The EC's Recovery and Resilience Facility website hosts the national RRF plans for each MS. The sections of these plans that relate to digital education and skills were included in the analyses for this report. Where needed, the JRC used the EC's eTranslation facility[498] to create English-language versions of the national RRF plans.

The thematic analysis of the RRF plans presented here has some important differences with respect to 'official' Commission treatment such as digital and climate tagging and pillar tagging. This is further explained under section 2.2.7 (Caveats).

2.2.3 Structured Dialogue process and documentation

The SD is a process of exchange on digital education and skills between the Commission and the MS which ran during 2022.

The dialogue was conceived and implemented in a transversal whole-government approach, co-ordinated in the EC by the Secretariat-General (SG) and implemented in close cooperation by the Directorate Generals (DGs) Education and Culture (EAC), Communications Networks, Content and Technology (CNECT), and Employment, Social Affairs and Inclusion (EMPL), with support from the Recovery and Resilience Task Force (SG RECOVER) and the DG for Economic and Financial Affairs (ECFIN).

The objective of the dialogue is to support MS in the digital transformation of their education and training systems in an integrated, coherent and more ambitious approach. This includes increasing the political visibility and commitments on digital education and skills, so that Europe is able to deliver on its 2030 targets in this area, as defined in the European Education Area, Digital Education Action Plan, Skills Agenda and the Digital Decade. Its purpose was to share experiences and lessons learned, successes, good practices, and challenges.

Interaction with all 27 MS took place through individual bilateral meetings, meetings of a high-level group of national coordinators for digital education and skills, and discussions in relevant Council formations.

The discussions in the dialogue were structured according to five themes or pillars:

- Pillar 1: Impact-focused investment
- Pillar 2: The place of digital competence in education and training systems
- Pillar 3: Governance of digital education, training and skills policies
- Pillar 4: The role of industry, social partners and other stakeholders
- Pillar 5: Contents of digital competence frameworks – advanced digital skills in the labour force.

In addition to the proposals for two Council Recommendations, the outcomes of the dialogue will feed into the national plans under the 2030 Policy Programme Path to the Digital Decade.

The Structured Dialogue documentation used in the analysis comprised:

- presentations prepared by each Member State
- notes and minutes of discussions during the Structured Dialogue meetings
- publicly available information and evidence on the state of play on digital education and skills at the national level, from a range of sources including the Digital Economy and Society Index (DESI)[499], the Digital component of the Resilience Dashboard[500], Eurydice's comparative review of digital

[497] See https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en and https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/index.html?lang=en

[498] https://ec.europa.eu/info/resources-partners/machine-translation-public-administrations-etranslation_en

[499] https://digital-strategy.ec.europa.eu/en/policies/desi

[500] https://ec.europa.eu/info/strategy/strategic-planning/strategic-foresight/2020-strategic-foresight-report/resilience-dashboards_en

education[501] as well as data from large-scale international assessments (the Programme for International Student Assessment [PISA], Teaching and Learning International Survey [TALIS], International Computer and Information Literacy Study [ICILS]) and the 2nd ICT survey of schools: ICT in education (ESSIE2).

2.2.4 Submissions to the Calls for Evidence

The EC launched two Calls for Evidence (corresponding to each of the Council Recommendation areas) which ran from August 1 to September 16, 2022.[502]

Table 2.1 shows the number of submissions by stakeholder type, while Table 2.2 shows the distribution of submissions by country. The high number of submissions overall reflects the high degree of interest in and concern about the topics: 88 submissions were received for enabling factors (with 42 of these accompanied by a paper) and 95 submissions were received on digital skills (48 of these with papers).

In both cases, the largest group making submissions (around one-third) were stakeholders in the non-profit or non-government (third) sector. Academic/research institutions, businesses/companies, and business associations were also well represented, with roughly one in 10 submissions. Public authorities and trade unions were just slightly less common, while 15% of enabling factors submissions, and 19% of digital skills submissions, were from individual citizens, a large majority of whom were EU citizens.

Submissions were received from organisations and individuals in 21 of 27 MS (18 MS submitted on enabling factors, and 19 submitted on digital skills). The high number of submissions received from Belgium is reflective of the fact that many pan-European organisations are based in Belgium.

Table 2.1. Summary of submissions to the Calls for Evidence by Stakeholder Type

Submission type	Council Recommendation Area: all submissions				Council Recommendation Area: papers			
	Enabling factors		Digital skills		Enabling factors		Digital skills	
Organisation	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Academic/research institution	12	13.6	8	8.4	5	11.9	5	10.4
Business/company	7	8.0	10	10.5	3	7.1	7	14.6
Business association	11	12.5	11	11.6	9	21.4	9	18.8
Non-profit or non-government organisation	28	31.8	30	31.6	14	33.3	13	27.1
Public authority	7	8.0	6	6.3	2	4.8	4	8.3
Trade union	4	4.5	2	2.1	4	9.5	1	2.1
Other	6	6.8	10	10.5	3	7.1	0	0.0
Individual	13	14.8	18	18.9	2	4.8	9	18.8
Total	**88**	**100.0**	**95**	**100.0**	**42**	**100.0**	**48**	**100.0**

[501] https://eurydice.eacea.ec.europa.eu/topics/digital-education

[502] Available in all EU languages here https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13207-Digital-education-enabling-factors-for-success_en and here https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13208-Digital-skills-improving-their-provision_en.

Table 2.2. Summary of submissions to the Calls for Evidence by Country

Submission source	Council Recommendation Area: all submissions				Council Recommendation Area: papers			
	Enabling factors		Digital skills		Enabling factors		Digital skills	
Country: EU	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Austria	3	3.4	0	0.0	2	4.8	0	0.0
Belgium/pan-European/international*	29	33.0	26	27.4	19	45.2	19	39.6
Bulgaria	1	1.1	1	1.1	1	2.4	1	2.1
Croatia	1	1.1	0	0.0	0	0.0	0	0.0
Czech Republic	4	4.5	3	3.2	1	2.4	1	2.1
Denmark	2	2.3	2	2.1	1	2.4	2	4.2
Finland	5	5.7	5	5.3	2	4.8	1	2.1
France	4	4.5	3	3.2	2	4.8	2	4.2
Germany	8	9.1	11	11.6	5	11.9	6	12.5
Greece	3	3.4	5	5.3	0	0.0	1	2.1
Ireland	2	2.3	5	5.3	0	0.0	2	4.2
Italy	3	3.4	6	6.3	1	2.4	3	6.3
Lithuania	0	0.0	1	1.1	0	0.0	1	2.1
Malta	1	1.1	1	1.1	1	2.4	1	2.1
Netherlands	7	8.0	5	5.3	1	2.4	2	4.2
Portugal	0	0.0	1	1.1	0	0.0	0	0.0
Romania	1	1.1	1	1.1	0	0.0	0	0.0
Slovakia	2	2.3	5	5.3	1	2.4	0	0.0
Slovenia	0	0.0	1	1.1	0	0.0	0	0.0
Spain	7	8.0	6	6.3	2	4.8	2	4.2
Sweden	1	1.1	1	1.1	0	0.0	1	2.1
Country: Non-EU								
Norway	1	1.1	0	0.0	1	2.4	0	0.0
Switzerland	0	0.0	1	1.1	0	0.0	1	2.1
Turkey	2	2.3	0	0.0	1	2.4	0	0.0
Uganda	0	0.0	1	1.1	0	0.0	0	0.0
United Kingdom	0	0.0	2	2.1	0	0.0	0	0.0
United States of America	1	1.1	1	1.1	1	2.4	1	2.1
Country not mentioned	0	0.0	1	1.1	0	0.0	1	2.1
Total	**88**	**100.0**	**95**	**100.0**	**42**	**100.0**	**48**	100.0

*All of the submissions classified as Belgium (other than those received from individuals) refer to pan-European or international organisations.

2.2.5 Analysis

The following steps were applied to the analysis: topic identification; tagging; consistency review; descriptive statistical analysis; and qualitative content analysis. Each is described in more detail below.

1. Identification of **topics** within the text studied. During the pilot phase the JRC team refined the set of topics that were proposed by DG EAC by allowing topics to emerge iteratively in the text analysis.

2. Throughout the analysis of the SD and submissions to the CfE, we refer to **topic instance** as the unit of analysis. In the RRF national report analysis, the relevant sections of national reports (i.e. all sections covering digital education and skills) were extracted and organised by RRF component and sub-component. Thus, for the RRF analysis we firstly identified **sub-component** as the unit of analysis (classifying this according to investment/reform and by digital skills provision/enabling factor). Then we identified the **topic or topics** covered by each sub-component to bring a unity to the analysis across the three sources of information.

   For the **RRF and SD** analysis, we report **both** the **number of topic instances** and the **number of MS** in which a particular topic was referenced, in addition to the **overall frequency of topic** instances. This provides information, respectively, on (i) how widespread across MS the topic is; (ii) how prominent the topic is across the EU as a whole. Care was taken to ensure that topic instances were not duplicated within MS. For example, if the structured dialogue meeting notes referred to the same initiative multiple times, the initiative was treated once in the input file for that MS.

3. For each topic identified within the analyses of the three sources of information, a further classification was made as follows:

   - **Group** (target group for the topic identified, tagged as primary, secondary, VET, Higher Education, Adult education, Disadvantaged group(s), Special education, Women/girls, Employers/employees, Jobseekers, Population, and Other)
   - **Geographic level** (whether the topic is targeted at an international, national, regional or mixed level of implementation)
   - **Public/private** (whether the topic consists of publicly, privately, or mixed management and funding structures), and
   - **Sector** (whether the topic is targeted at the education sector, the employment sector, or a mixture of these).

   An **engagement/partnership** indictor was applied to SD data, where the topic showed evidence of collaboration, engagement or partnership, which could take multiple forms: across Government departments, levels of Government, Government and social partners, public and private entities, schools, communities, and/or individual teachers/educators. Specifically, each topic was classified in accordance with whether it explicitly or necessarily involved **partnership** or **engagement**. The classification of partnership was reserved for cases in which co-creation or joint decision-making was an explicit or necessary feature, while engagement was applied to cases where communication or collaboration across groups or actors was a prominent feature.

4. Once the initial classification was made by the first analyst, a second analyst reviewed all classifications to ensure **consistency**, with discussion and agreement on revisions and the ongoing maintenance of a query log to support this work.

5. The input files for each MS were merged and **descriptive statistics** were computed on the topics and classifications.

6. As a final step, the content of commentary within each topic was subjected to a **content analysis** to identify emerging themes.

2.2.6 Emerging topics

Tables 2.3 to 2.6 list the topics that emerged under the three sets of analysis.

These topics are elaborated on in more detail in Sections 3 and 4.

Table 2.3 shows the topics that emerged from the thematic analysis of the sections of the RRF national reports that deal with digital education and skills reforms and investments. In all, 12 topics emerged (9 associated with enabling factors and 8 associated with digital skills provision, with 5 of these common to both Council Recommendation areas).

Table 2.3. Topics emerging from the analysis of relevant components/sections of RRF national plans

RRF topic	Enabling factors	Digital skills provision
Digital content, tools and platforms	x	
Equity, inclusion and wellbeing	x	x
Infrastructure, connectivity, equipment	x	
Initiatives to boost digital skills in education settings, *including curriculum reforms*		x
Initiatives to boost digital skills outside formal education		x
ITE and CPD, digital pedagogy	x	
ITE and CPD, digital skills		x
Legislative or governance reform	x	x
Monitoring, evaluation and assessment	x	x
Networking/collaborative supports/activities	x	
Opportunity and innovation	x	x
Research and data	x	x

*ITE: initial teacher education; CPD: continuing professional development

As noted earlier, the initial unit of analysis for the RRF documentation was sub-component, classified as investment or reform, and then with one or more topics identified within each sub-component. Table 2.4 provides information on the distribution of RRF sub-components across these dimensions.

In total across the 27 MS, we identified 321 relevant sub-components. There are relatively more sub-components classified as digital skills provision (59%) compared to enabling factors for digital education (41%). On average across all sub-components, just over two topics (2.10) were assigned to each sub-component. At the topic level, 41.5% related to enabling factors, and 58.5% to digital skills.

Table 2.4. Distribution of RRF national report sub-components on digital skills and digital education by investment, reform and topic instance

	Total sub-components		*Total topics*		*Average topics per sub-component*
Aspect of RRF	*N*	*%*	*N*	*%*	
Enabling factors	**132**	**41.1**	**279**	**41.5**	**2.11**
Investments	90	28.0	190	28.2	2.11
Reforms	42	13.1	89	13.2	2.12
Digital skills	**189**	**58.9**	**394**	**58.5**	**2.08**
Investments	111	34.6	224	33.3	2.02
Reforms	78	24.3	170	25.3	2.18
Total	**321**	**100.0**	**673**	**100.0**	**2.10**

Table 2.5 lists the topics identified in the analysis of the SD documentation. Similar to the RRF topics, there is an overlap in topics emerging across the two Council Recommendation areas: a total of 11 topics emerged; four of these appeared across both Council Recommendation areas.

Table 2.5. Topics emerging from the thematic analysis of Structured Dialogue documentation

Structured Dialogue topic	**Enabling factors**	**Digital skills provision**
Digital content, tools and platforms	x	
Equity, inclusion and wellbeing	x	x
Infrastructure, connectivity, equipment	x	
Initiatives to boost digital skills outside of formal education settings		x
Initiatives to boost digital skills in formal education settings, *including curriculum reforms*		x
ITE and CPD, digital pedagogy*	x	
ITE and CPD - digital skills/competence		x
Monitoring, evaluation and assessment (for *digital skills provision*, this includes digital skills certification/accreditation)	x	x
Networking/collaborative supports/activities	x	
Opportunity and innovation	x	x
Research and data	x	x

*ITE: initial teacher education; CPD: continuing professional development.

Table 2.6 shows the topics emerging from the CfE for each Council Recommendation area. In total, 13 topics emerged. Four of these emerged across both enabling factors and digital skills provision.

Table 2.6. Topics emerging from the analysis of the submissions to the Calls for Evidence

CfE Submission Topic	Enabling factors	Digital skills provision
Cybersecurity and data skills		x
Digital pedagogies	x	
Digital skills certification/accreditation/assessment		x
Digital skills gaps		x
Digital skills provision in formal education, *including curricular content and reform*		x
Digital skills initiatives outside formal education		x
Equity, inclusion and wellbeing	x	x
Infrastructure, connectivity, and equipment	x	
Monitoring and evaluation; impact assessment (including policies and frameworks for digital skills)	x	x
Networking, collaboration and capacity building	x	x
Professional development, teachers and educators	x	
Digital skills policies and frameworks		x
Public-private partnerships	x	x

Looking across Tables 2.4-2.6, one can see considerable commonality, as well as topics that are specific to each source. For example, the RRF analysis includes legislative or governance reforms as a separate topic; while this area is covered in a transversal way within a sub-analysis of governance, engagement and partnership; and the CfE submissions (only) include cybersecurity and data protection and skills. These differences reflect the different purposes and perspectives of the three sources of information used in the analysis. Section 5 attempts to bring the results together into a set of higher-order themes that highlight: (i) themes emerging across all sources (reflecting common priorities or concerns), and (ii) themes which emerged more strongly (or solely) in just one or two of the sources (reflective of specific perspectives).

2.3 Caveats

Caveats and limitations to the analyses are both general (across all three sources of information) and specific to a source:

General caveats

- The analysis is primarily thematic, designed to give an indication of the areas of focus and common challenges that are relevant for EU policies and should be interpreted in combination with other complementary sources of evidence. Results should not be considered as providing a comprehensive factual overview of the situation across MS.
- The analysis is focused on a cross-country synthesis of emerging themes rather than an attempt to describe individual MS. Given this approach, it is important to be mindful of the variation in national and regional contexts. In particular, MS vary in the organisation and governance of their education and training systems, and in the overall level of digital maturity of these systems.
- The cross-country synthesis approach means that the analysis does not examine the instances of actions or initiatives within individual MS. Subsequent analysis of this data could attempt to identify particular combinations of approaches within MS that are associated with comprehensive digital education ecosystems and high levels of success in the provision of digital skills.
- The content of the sources used in the analysis varies in level of detail. In some cases, much detail on initiatives was provided; in others, less detail was available. Where feasible, the input material has been supplemented with web-based research of national strategies or initiatives. It is important to highlight that the analysis is not intended to be comprehensive and may not include some initiatives/strategies that were not mentioned in the materials that were analysed.

- The content of the material analysed combines both existing and planned initiatives and actions; results should therefore be interpreted as providing information on the existing and emerging picture.

RRF caveats

- The RRF analysis indicates areas of planned reforms and investments up until 2026 and as such, we cannot be sure that future implementation will be in line with current information.
- Analysis is based on the national recovery and resilience plans as published by the national authorities. In case of discrepancies, the analysis is made without prejudice to the final version of reforms and investments to be financed under the Recovery and Resilience Facility, as adopted by the Council in Council Implementing Decisions.
- The treatment of the RRF national plans uses a methodology separate from the 'official' ones (climate and digital tagging; pillar tagging). Results are not published at MS level, only in aggregate.
- The RRF analysis in this report focuses on the content of the proposed reforms and investments of MS rather than on the magnitude of the financial investments.
- RRF national reports vary considerably in terms of their structure. Specifically, some MS grouped many initiatives or actions under a single sub-component, while others took a more granular approach. The number of records ranges per MS, from 1 to 34, such that MS taking a more granular approach will have contributed relatively more to the overall picture than MS taking a less granular approach. We have not attempted to address this through the use of weights or other adjustments.
- The assignment of more than one topic to a given sub-component results in some overlap in the themes under each of the topics. To address this, a summary of key findings is provided at the end of the RRF analysis.
- RRF national reports should not be regarded as a fully comprehensive picture of emerging and planned investments, since MS also invest national funds in a variety of ways; however, given the size of the funds covered under the RRF, they can nonetheless be considered as broadly indicative of where emerging investment and reform priorities lie.

Structured Dialogue caveats

- The content of the discussions in SD meetings with MS was guided by the five pillars as well as areas in which MS and the EC shared interest and concern, and areas for which the EC would have liked to learn more about; for example, adult education as it relates to digital skills was a topic often explored in the meetings due to a lack of available comprehensive information on this field. This means that the overall frequencies of topic instances should not be interpreted as the relative level of priority given to them. For this purpose, it is advisable to focus instead on the number of MS in which each topic (and related challenges) was identified.
- MS varied in terms of the extent to which the SD focused on current and forthcoming plans represented in their RRF national plans. Some made this a main focus of the dialogue, while others mentioned the RRF in passing, focusing also on actions and initiatives that had been recently completed.

CfE caveats

- Unlike the RRF and SD documentation, the CfE submissions were 'pre-classified', in that separate submissions were made under each of enabling factors and digital skills provision. Some of the content of the submissions on digital skills included enabling factors topics, and vice versa. About 20% of the analysed content of the CfE submissions on enabling factors consisted of digital skills topics, while only 5% or so of the analysed content of the CfE submissions on digital skills consisted of enabling factors topics. In these instances, the topics were re-assigned from digital skills to enabling factors submissions and vice versa.
- The relative emphases given to the various themes in the submissions to the CfE reflect the perspectives of the stakeholders, and it should be borne in mind that submissions were more frequent for some stakeholder types (e.g. non-governmental or non-profit organisations) and less for others (e.g. Trade Unions). In the results in Sections 3 and 4, we provide comparisons of topic frequencies across stakeholder types.

3 Enabling factors for successful digital education

This section provides a summary of the topics and themes emerging from the thematic analysis as they relate to enabling factors for digital education. First, the results of the RRF analysis are presented. This is followed by the results from the SD analysis; and, finally, the topics and themes emerging from the CfE submissions.

3.1 Enabling factors in RRF national plans

3.1.1 Topic analysis overview

As noted in Section 2, each sub-component of the relevant sections of the RRF national reports were classified firstly as investment or reform. Then, working from a combination of pre-defined and emerging topics (whilst at the same time aiming for topic unity across RRF, SD and CfE sources) each investment and reform item was assigned one or more topics. Table 3.1 provides short descriptions for each topic, while Figure 3.1 shows the distribution of topics across investments and reforms.

In interpreting the results, recall that analysis focuses only on content and not on size of investment.

Table 3.1. Descriptions of topics in the thematic analysis of RRF national plans enabling factors

Topic	Description
Legislative or governance reform	Broad legislative or governance reforms to support the implementation of enabling factors for a digital education ecosystem
Infrastructure, connectivity, equipment	Reforms or investments relating to the provision of infrastructure (hardware including servers), connectivity (enabling high-speed transmission of digital content and processes), and equipment (including peripherals and assistive technologies)
Digital content, tools and platforms	Reforms or investments relating to digital content, tools and platforms to support teaching and learning
ITE and CPD, digital pedagogy	Reforms or investments relating to initial teacher education, continued professional development of teaching staff focused on digital pedagogy
Research and data	Reforms or investments supporting enabling factors-related research and data activities, e.g. national research study
Equity, inclusion and wellbeing	Reforms or investments relating to enabling factors targeted at specific groups including socio-economically disadvantaged persons, women, older persons
Monitoring, evaluation, assessment	Reforms or investments relating to the monitoring, evaluation or assessment of enabling factors, such as impact assessment or monitoring of infrastructural investment
Networking/collaborative supports	Reforms or investments supporting activities that foster collaborative work and network-based support for educators, teaching staff, students, etc.
Opportunity/innovation	Reforms or investments relating to innovations in enabling factors (e.g. in emerging technologies infrastructure)

For **reforms**, the most frequent topics related to infrastructure, connectivity and equipment (23%); digital content, tools and platforms (20%); and broad legislative or governance reforms relating to digital education 21%). In terms of **investments**, the most frequent topic related to investment in infrastructure, connectivity and equipment (38%), followed by digital content, tools and platforms (22%).

Figure 3.1 also includes a category for investments and reforms of other topics: these comprise topics shown in Table 3.1 above for which frequencies were less than 2.5%.

We do not provide a separate analysis of topics with frequencies of less than 5% (rounded), since there is an insufficient number of cases to provide reliable or generalisable information.

Figure 3.1. Distribution of RRF national report topics on enabling factors (%), by investment and reform

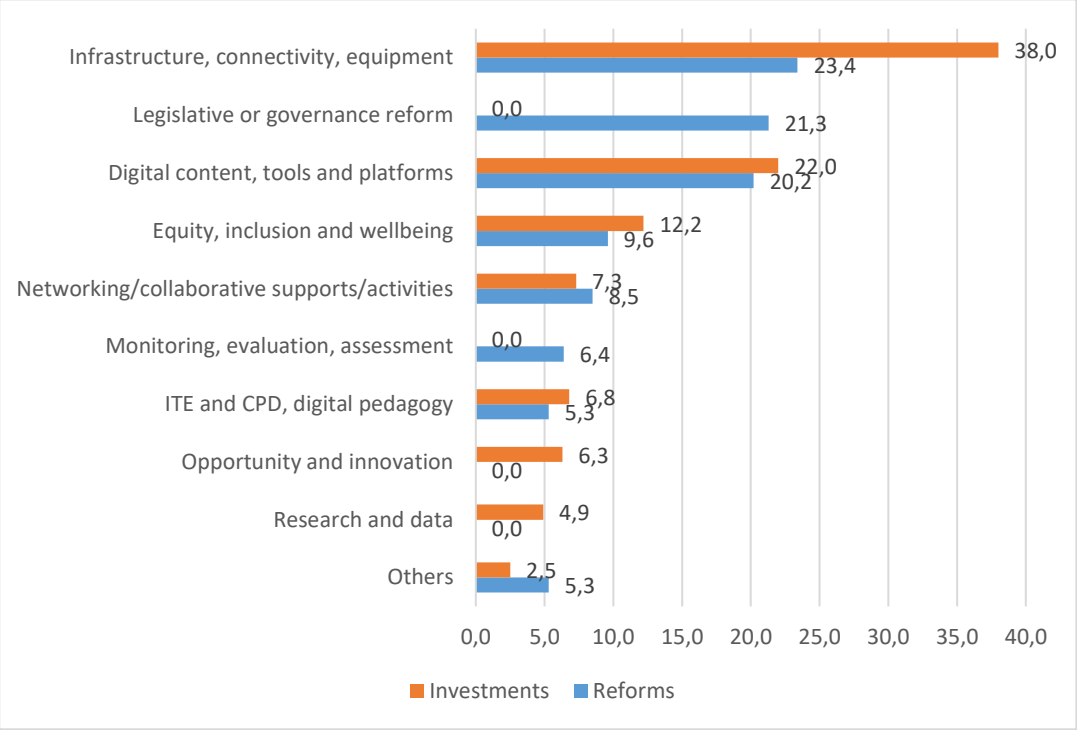


Table 3.2 shows the number of MS in which the enabling factors 'reforms' and 'investments' were mentioned. The three most frequent **reforms**, classified by topic, relate to infrastructure, connectivity and equipment (14 MS); digital content, tools and platforms (14 MS); and general legislative or governance reforms related to enabling factors (10 MS). Other topics featured in the reforms of between two and five MS.

Consistent with the reforms, **investments** relating to infrastructure, connectivity and equipment (23 MS) and to digital content, tools and platforms (18 MS) were the most frequently referenced. In addition, investments to support equity, inclusion and wellbeing featured in 12 MS and the RRF national plans of 9 MS referenced investments in ITE/CPD in digital pedagogies. The remaining enabling factors investment topics featured in two to seven MS.

Table 3.2. Distribution of enabling factors reform and investment topics from RRF national plans across 27 MS

Topic	Reforms	Investments
Infrastructure, connectivity, equipment	14	23
Digital content, tools and platforms	14	18
Legislative or governance reform	10	0
ITE and CPD, digital pedagogy	5	9
Monitoring, evaluation and assessment	5	2
Networking/collaborative supports/activities	5	7
Equity, inclusion and wellbeing	4	12
Research and data	3	6
Opportunity and innovation	2	7
Others	2	2

3.1.2 Themes emerging from the RRF analysis

In interpreting the results it should noted that there is overlap across topics in the themes emerging. This is because multiple topics have been assigned to each sub-component. It should also be recalled from Section 2 that there is a wide variation in the number of sub-components (and hence topics) associated with each MS. The end of this section provides a short summary of key findings.

3.1.2.1 Legislative and governance reforms

The RRF sub-components under this topic from 10 MS included reference to broad legislative or governance reforms.

- About a quarter of these consisted of legislative reforms to enable investments in primary and secondary schools, relating to large-scale investment in infrastructure, connectivity and/or equipment; reforms to enable ITE and CPD in digital pedagogies; and reforms to implement evaluation systems for schools and/or teachers.
- A further one-quarter or so consisted of comprehensive reforms of Higher Education, covering aspects such as governance, digitalisation or modernisation, training, career progression, research/development/innovation activities, and cross-institutional and public-private collaborations.
- Another quarter or so described the development or enactment of national frameworks, such as for digital education reform, cybersecurity strategy, data in society strategy, and reform of the VET sector.
- The remainder consisted of legislative reform for broad infrastructure, connectivity and/or equipment projects (e.g. large-scale broadband connectivity or public administration/services cloud solutions), and reforms to support, regulate or strengthen research, development and innovation in both public and private sectors.

3.1.2.2 Infrastructure, connectivity and equipment

Reforms relating to infrastructure, connectivity and equipment in 14 MS referred to (ordered from most to least frequent):

- Reforms to implement infrastructural or connectivity investments in formal education settings (primary, secondary, VET and Higher Education, and including special educational supports);
- Legislative reforms to support or accelerate broadband connectivity projects (many of these prioritising areas/regions based on need); and
- The development of policies or strategies which are related to digital education and which include elements of infrastructure, connectivity and/or equipment.

About one-fifth of **investments** (across 23 MS) targeted primary and secondary education, one-fifth Higher Education settings, and about one-eighth focused on VET settings. Some of the investments in formal education settings referred solely to one of these three aspects of an enabling digital education ecosystem (e.g. devices for learners only), though a majority of the investments took a holistic perspective. It was more common in Higher Education than at other levels of the formal education system to refer to investments in infrastructure or equipment to support research and skills in innovative or emerging digital technologies. In contrast, within primary and secondary, there was more of a focus on investment in devices for students/learners and school infrastructure. In VET settings, these investments were commonly accompanied by investments to digital skills training offers in response to existing and emerging labour market need. A common theme across these investments was targeting to tackle the digital divide, e.g. prioritising these investments to disadvantaged students or school communities.

Around one in eight of the investments referred to infrastructure, connectivity or equipment in non-formal education settings (youth centres, libraries, etc.), where digital inclusion was a central focus.

One-fifth of investments referred to high-speed broadband connectivity projects. Two aspects of these were quite common: investments to address remaining gaps in connectivity (for example in rural and remote communities), and investments to upgrade all or parts of the connectivity infrastructure to higher connectivity speeds, with many MS referencing both objectives within their national RRFs.

The remaining investments under this topic referred to both the public and private sectors, consisting of infrastructural investments to support the digitalisation of public services or business, and SMEs in particular. A small number referred specifically to cybersecurity.

In general, with the exception of the large-scale broadband connectivity investments, it was the norm for investments in infrastructure, connectivity or equipment to occur alongside investments in digital skills reskilling or upskilling.

3.1.2.3 Digital content, platforms and tools

The most frequently occurring targets of **reforms** relating to digital platform, content and solutions in 14 MS were primary, secondary and Higher Education levels, where these reforms supported the implementation of investments to develop digital learning content (as part of curricular revisions or reforms to CPD of educators) and/or platforms to support teaching, learning and interoperability between institutions or between levels of the education system (e.g. development of a unified platform to enable the flow of digital content and school data between central and school-level actors). A small number of reforms in this area referred to the development of platforms or other digital supports for public services including public employment services.

One-third of **investments** relating to content, tools and platforms across 18 MS referred to primary and/or secondary schools or to the formal education system more broadly, while a further one-sixth referred to Higher Education, and about one in ten referred to VET. Key emerging themes in these investments, particularly in VET and Higher Education settings, were personalised and self-directed learning, flexibility, and solutions to support hybrid teaching and learning. Investments are targeted at both educators and learners.

Of the remaining investments, these were evenly distributed across the public sector, businesses and vulnerable groups as their targets. Regarding the public sector, investments support data integration and modernisation, cybersecurity solutions, and the adoption of innovative technologies. In the business environment, investments referred to digital solutions to support efficiency and innovation. Investments targeted specifically to vulnerable groups refer to digital learning content and solutions to enable skills training for jobseekers, youth, older persons, and prison detainees, accompanied by infrastructural investments.

All of the investments in digital content, platforms and tools are accompanied by investments in education and skills training offers.

3.1.2.4 Networking/collaborative supports/activities

Half of the small number of **reforms** featuring networking or collaborative supports or activities (in five MS) were targeted at formal education, either primary and/or secondary, or Higher Education. These reforms included references to new collaborative support structures (e.g. new regional IT support staff for schools) and/or to encourage or strengthen inter-institutional collaboration. The remaining reforms were split across the public and private sectors and entailed the establishment of new collaborative structures, including public-private partnerships. There were a very small number of governance reforms aimed at a co-ordinated approach across the public sector.

Investments featuring networking or collaborative supports or activities were referenced in seven MS. Two-fifths or so were targeted at Higher Education and comprised the support for participation in European research networks/structures, the strengthening of international links, and/or the establishment of digital competence hubs to support staff and/or students. A further one-third or so of these investments were targeted at primary and secondary schools and consisted of the establishment of teacher collaboration structures (as part of broader CPD activities), advisory/support centres, or IT support. Around a quarter of investments targeted VET systems, consisting of the establishment of regional clusters, centres of excellence, and/or structures to facilitate public-private or multi-stakeholder partnerships. A very small number of investments featuring this topic referred to the establishment of innovation hubs or competence centres in the public services and business sectors.

3.1.2.5 Monitoring, evaluation and assessment

Reforms which featured monitoring, evaluation and assessment were identified in five MS. These referred to measures to implement monitoring of digital education strategies. These operated at different levels of the

system, ranging from high-level (e.g. reform to enable education policy monitoring at the national level or to implement a monitoring and tracking system of students) to more local levels (e.g. reform to implement a new school and teacher evaluation system), or within a specific sector of education (e.g. a reform to enable transversal co-ordination of VET).

Investments featuring this topic were referenced in just two MS and covered less than 5% of all investment topics, so are not reported on here. As noted in Section 3.1.1, there are too few cases for a robust description to be provided.

3.1.2.6 Opportunity and innovation

Reforms featuring opportunity and innovation were referenced in two MS, and covered less than 5% of all reform topics, and so are not reported on here.

Investments which featured opportunity and innovation were referenced in seven MS. These related either to:

- Investments in the research/development/innovation (RDI) ecosystems, for example to support digital research infrastructure deployment in HEIs (commonly with an international focus and with links to broader RDI efforts or strategies), the establishment of digital innovation hubs for Higher Education and/or businesses, or structures to support RDI collaborations between Higher Education and businesses;
- Investments to support the deployment of emerging and advanced digital technologies, for example the establishment of regulatory frameworks or governance structures to support development/deployment of emerging and advanced technologies in education and/or employment sectors.

3.1.2.7 ITE and CPD, digital pedagogy

Reforms which referred to ITE and CPD in digital pedagogy featured in five MS, and were targeted at primary and secondary levels of the formal education system, or to Higher Education, with just one reform referring specifically to supporting special education needs.

Two-thirds of **investments** that made explicit reference to ITE or CPD in digital pedagogies (in nine MS) were targeted at primary and secondary education; the remaining one-third were evenly divided across VET and Higher Education settings. Regarding primary and secondary school investments, investments largely consisted of CPD to support educators in the use of digital technologies to support curricular reform and/or hybrid learning.

In VET and Higher Education settings, meanwhile, investments related primarily to CPD to support hybrid or distance learning, and/or to support recent or planned reforms to course offerings. Common themes in VET and Higher Education contexts were relevance to existing and emerging labour market demand, flexibility and innovative approaches.

3.1.2.8 Research and data

Reforms featuring the research and data topic featured in three MS, and covered less than 5% of all reform topics, and so are not reported on here.

A small number of **investments** that supported research and data on enabling factors were identified (in six MS). These were mainly targeted at the Higher Education and national research communities and consisted of references to further research and/or data collection efforts on enabling factors in digital education systems or investments to support data policy implementation. They also commonly referred to developing existing or new links to the broader European research communities.

3.1.3 Summary of RRF national report findings

Broad legislative and governance reforms relating to enabling factors featured in the RRF national plans of 10 MS and comprised 21% of all reform topics. Half of these were targeted at primary/secondary and/or Higher Education and related to reforms to facilitate implementation of digital education strategies or Higher Education reforms. A quarter referred to development/enactment of broad reforms or policies relating to digital education, cybersecurity, data, or VET systems. The remainder consisted of legislative reforms to enable deployment of large-scale connectivity or cloud solutions projects.

Reforms relating to **infrastructure, connectivity and equipment** in 14 MS (23% of reform topics) most commonly enabled infrastructural/connectivity investments in formal education settings. They also included legislative reforms to support/accelerate broadband connectivity projects, and development of digital education policies or strategies. About one-fifth of investments in 23 MS (38% of investment topics) targeted primary and secondary education, one-fifth Higher Education setting, and about one-eighth focused on VET settings. A majority of investments took a holistic perspective, considering multiple infrastructural elements. In Higher Education, investments commonly supported research and skills in innovative or emerging digital technologies. In VET, investments were commonly accompanied by modernising of training offers to incorporate digital skills training in response to existing and emerging labour market need. Around one in eight of the investments referred to infrastructure, connectivity or equipment in non-formal education settings where digital inclusion was a central focus. It was the norm for these investments to occur alongside investments in digital skills reskilling or upskilling. A further one-fifth of investments referred to high-speed broadband connectivity projects, and a small number of investments referred to cybersecurity infrastructure.

The most frequently occurring targets of reforms relating to **digital platform, content and solutions** in 14 MS (20% of reform topics) were primary, secondary and higher levels of education, where they supported the implementation of investments to develop digital learning content and/or for teaching and learning, and/or interoperability between institutions or between levels of the education system. One-third of investments featuring this topic across 18 MS (covering 22% of investment topics) referred to primary and/or secondary schools or to the formal education system more broadly, while a further quarter or so referred to Higher Education, and about one in ten referred to VET. Emerging themes in these investments, particularly in VET and Higher Education, were personalised and self-directed learning, flexibility, and solutions to support hybrid teaching and learning. The remaining investments were distributed across the public sector (to support data integration, cybersecurity, and innovative technology adoption); the business sector (to support efficiency and innovation); and targeted at vulnerable groups (to enable skills training). All of these investments are accompanied by education and skills training offers.

Half of the small number of reforms featuring **networking or collaborative supports or activities** (in five MS and comprising 7% of reform topics) were targeted at formal education, either primary and secondary, or Higher Education. These reforms included references to new collaborative support structures (e.g. new regional IT support staff for schools) and/or to encourage or strengthen inter-institutional collaboration. The remaining reforms were split across the public and private sectors and entailed the establishment of new collaborative structures, including public-private partnerships. There were also a very small number of governance reforms aimed at a co-ordinated approach across the public sector. Investments featuring this topic were referenced in seven MS (and covered 8.5% of investment topics). Two-fifths or so were targeted at Higher Education and comprised support for strengthening international links, and/or the establishment of digital competence hubs for staff and/or students. A further one-third were targeted at primary and secondary schools for teacher collaboration structures, advisory/support centres or IT support. Around a quarter of investments targeted VET systems (e.g. for centres of excellence or multi-stakeholder partnership structures). A very small number referred to the establishment of innovation hubs or competence centres in the public services and business sectors.

Reforms which featured **monitoring, evaluation and assessment** (in five MS and accounting for 6% of reform topics) referred to measures to implement monitoring features of digital education strategies, operating at different levels of the system, ranging from high-level to more local levels, or within a specific sector of education (e.g. VET). Investments featuring this topic were too few in number to report on separately.

Reforms featuring **opportunity and innovation** were also too few in number to report separately. Investments featuring this topic were referred to in the RRF national plans of seven MS and comprised 6% of all investment topics. They related to investments in research/development/innovation (RDI) ecosystems or for the deployment of emerging and advanced digital technologies in settings both inside and outside of education.

Reforms which referred to **ITE and CPD in digital pedagogy** featured in five MS (5% of reform topics), and were targeted at primary and secondary levels of the formal education system, or to Higher Education, with just one reform referring to special education needs. Two-thirds of investments in nine MS under this topic (7% of all investment topics) were targeted at primary and secondary education and focused on CPD for educators on the use of digital technologies for teaching and learning to support curricular reform and/or hybrid learning. The remaining one-third were evenly divided across VET and Higher Education settings, where investments

related primarily to CPD to support hybrid or distance learning, and/or to support recent or planned reforms to course offerings, focusing on existing and emerging labour market demand.

There were too few reforms featuring the **research and data** topic to report on separately. A small number of investments (5% of topics) were identified in six MS. These were mainly targeted at the Higher Education and national research communities and consisted of references to further research and/or data collection efforts on enabling factors in digital education systems or investments to support data policy implementation. They also commonly referred to developing existing or new links to the broader European research communities.

There are some important **gaps** in the content of the RRF national plans as they relate to enabling factors for digital education.

- First, there is very little emphasis on monitoring, evaluation and impact assessment. While it may be the case that monitoring, evaluation and impact assessment are built into existing policy implementation (indeed, in some MS their RRF plans are embedded in their national strategies, and in these strategies there is provision or reference to monitoring), it could nonetheless be a concern that the RRF national plans did not routinely build references to monitoring, evaluation or impact assessment in order to be able to assess the efficiency and effectiveness of major investments and reforms. This theme is further explored in the next section which discusses the findings of the SD meetings.
- Secondly, while some RRF national plans made explicit provision for enabling factors relating to disadvantaged or vulnerable groups, the monitoring of investments and reforms in this regard is less clear. This could suggest, in conjunction with the first point, that any effort to focus more on monitoring and evaluation should include a particular focus on these groups.
- Thirdly, while it must be acknowledged that this is a broad, qualitative analysis, it is nonetheless striking that the references to investments in infrastructure, connectivity and equipment are more frequent than references to other foundational enabling factors, i.e. digital content, platforms and tools; and CPD and ITE in digital pedagogies. Of course, it may be the case that investments in these latter areas are funded by other national or European sources. The SD discussions provide further valuable insights into MS' priorities with respect to the various enabling factors.

3.2 Enabling factors in the Structured Dialogue

3.2.1 Topic analysis overview

Through a combination of pre-defined and emerging topic analysis, 8 topics were identified. Table 3.3 provides a description of topics.

Two main groups emerged in the SD when it comes to enabling factors (see Table 3.4):

Foundational enabling factors for successful digital education:

- Infrastructure, connectivity and equipment (22.5% of topic instances)
- Digital content, tools and platforms (19%)
- ITE and CPD for digital pedagogy (15%)
- Networking/collaborative supports/activities (8.5%).

Enabling factors that provide **direction, structure and value** for successful digital education:

- Monitoring, evaluation and assessment (18%)
- Equity, inclusion and wellbeing (10%)
- Opportunity and innovation (4%)
- Research and data (3%).

Table 3.3. Descriptions of topics in the thematic analysis of RRF national plans: enabling factors

Topic	Description
Infrastructure, connectivity, equipment	The provision of infrastructure (hardware including servers), connectivity (enabling high-speed transmission of digital content and processes), and equipment (including peripherals and assistive technologies)
Digital content, tools and platforms	Digital content, tools and platforms used for teaching, learning and assessment
ITE and CPD, digital pedagogy*	Initial teacher education, continued professional development of teaching staff focused on digital pedagogy
Networking/collaborative supports/activities	Supporting activities that foster collaborative work and network-based support for educators, teaching staff, students, etc.
Monitoring, evaluation and assessment	Activities relating to the monitoring, evaluation or assessment of enabling factors, such as impact assessment or monitoring of infrastructural investment. This topic also includes actions and systems to govern enabling factors implementation, such as investment subject to institutional compliance with given criteria
Research and data	Enabling factors-related research and data activities, e.g. national research study
Equity, inclusion and wellbeing	Initiatives on enabling factors targeted at specific groups including socio-economically disadvantaged persons, women, older persons
Opportunity and innovation	Innovative initiatives on enabling factors (e.g. in emerging technologies infrastructure) or opportunities identified to build on the existing enabling ecosystem

*Initiatives related to the enhancement of digital skills of teachers/educators are included under digital skills in Section 4.

Note. Challenges, barriers and concerns in the development or implementation of an enabling ecosystem for digital education, where referenced, are classified under the specific topic(s) to which they refer.

Table 3.4. Structured Dialogue frequencies of enabling factors topics (N = 719) and challenges within topics (n = 118), together with the count of MS (N = 27) in which each topic and topic-related challenge is referenced

Enabling Factors Topic	*N topic instances*	*% of all topic instances*	*N challenges within topic*	*% challenges within topic*	*N MS in which topic is referenced*	*N MS in which topic challenge is referenced*
Infrastructure, connectivity, equipment	162	22.5	30	25.4	27	16
Digital content, tools and platforms	139	19.3	8	6.8	26	6
Monitoring, evaluation, assessment	127	17.7	33	28.0	26	20
ITE and CPD, digital pedagogy	107	14.9	26	22.0	27	17
Equity, inclusion and wellbeing	70	9.7	18	15.3	26	14
Networking/collaborative supports/activities	61	8.5	2	1.7	24	2
Opportunity or innovation	30	4.2	0	0.0	16	0
Research and data	23	3.2	1	0.8	13	1
Total	719	100.0	118	16.4	N/A	N/A

On average across the 27 MS, 28 topic instances relating to enabling factors were identified (range = 16-47). With the exceptions of research and data, and opportunity and innovation, all topics were referenced in the SD of a large majority (24 to 27) of MS.

Overall, 16% of all topic instances referred to challenges or concerns. Topics in which challenges were most frequent are monitoring, evaluation and assessment (28%); infrastructure, connectivity and equipment (25%); and ITE and CPD for digital pedagogy (22%).

Specifically in relation to challenges, the topics most widely referenced across MS were again monitoring, evaluation and assessment (20 MS); infrastructure, connectivity and equipment (16 MS); and ITE and CPD for digital pedagogy (17 MS); and additionally, equity, inclusion and wellbeing (14 MS).

A transversal theme, **EU support** (not displayed in Table 3.4), provides a description of suggestions from MS as to how these various challenges may be addressed at the EU level. Roughly half of the 130 or so instances of EU support relate to enabling factors (the other half relate to digital skills).

We also examined the transversal theme of **governance, engagement and partnerships** under enabling factors and describe the results of this analysis in a later part of Section 3.

As described in Section 2, each topic was classified within the analysis framework along several dimensions: target **group**, **level** (international, national, regional, mixed), and **sector** (education, employment, mixed; and public, private or mixed public/private) to provide insight into the location within the ecosystem of each topic instance.

The remainder of this section describes the key themes and challenges under each topic in turn. This is followed by a summary of references to EU support, and a short summary of key findings.

3.2.2 Themes emerging from the Structured Dialogue analysis

3.2.2.1 Infrastructure, connectivity, equipment

Themes

There is a strong shared view among officials in all 27 MS that effective and equitable digital infrastructure, connectivity and equipment forms the foundation of a successful digital education ecosystem. Overall, a majority of the SD documentation that referred to infrastructure, connectivity and equipment investments (25% of topic instances) was at primary and secondary levels, with the remainder focused on Higher Education and VET. References to investments in infrastructure, connectivity and equipment tended to be more widespread among MS with less well-developed digital education ecosystems. We identified seven emerging trends.

- **Large-scale investment** in devices for students is extremely common, with many MS in addition referring to devices for teachers. These large-scale infrastructural investments, particularly within primary and secondary education systems, were occurring within broader digital education and/or digital skills strategies, and were commonly, though not always, accompanied by other enabling factors (such as digital content/tools/platforms; CPD and ITE in digital pedagogies, discussed below). Many MS were accompanying device investments for individuals with broader programmes of school or institutional digital infrastructural investments, for example, in the upgrading of classroom equipment, re-fitting of ICT laboratories with equipment to enable the teaching and learning of coding and programming using robotics (for example); and/or the teaching and learning of new and emerging technologies skills such as AI.
- A large majority of MS referenced recent investments in devices for students during the **pandemic**, providing either free or subsidised devices (occasionally these being accompanied by free or subsidised connectivity). There are three general trends with respect to measures targeted at **disadvantaged students** in this regard:

I. Provision of universal free learning content including devices to students
II. Identification, by some criterion, of disadvantaged learners and supplying them with free devices and occasionally other supports (such as connectivity or family support)s
III. Provision of subsidies or vouchers so that disadvantaged learners can access devices (and occasionally also connectivity) more inexpensively.

The above schemes largely appear to refer to socio-economically disadvantaged groups, and very occasionally more broadly to educational disengagement. There is little if any information in the SD as to what metrics were

used to identify the disadvantaged groups. Some MS provided devices to other groups such as the elderly population, with the onset of the pandemic within their broader digital inclusion agenda; and a small number also referred to investments at the pre-school level of the system.

- A few MS indicated **student-device ratio** targets they would like to achieve, while a small number of MS appear to have already met their targets in this regard. References to targets concerning learner-device ratios were not consistently made during the SD meetings. However, a general trend in this regard is for the provision of one device per student from upper primary level onwards and one device for every four or five students among younger grade levels. While in some MS the recent investments in devices has concluded, in a majority, this is set to continue under the RRF national plans.
- A specific aspect of these investments relates to the **choice of device** for students. An early emerging trend is that keyboard-free devices (tablets) are favoured by some MS for younger children, while devices with a keyboard are favoured for older children and (young) adults. The transitional and developmental needs of children (and the consequent implications for digital pedagogies) relating to keyboard and mouse skills is an issue that may merit further exploration.
- Just a small number of MS specifically mentioned **assistive technologies** investment. This is not to say that there is not investment and support in assistive technologies, but rather to note that the incorporation of assistive technologies at all levels of the education system is an issue that may merit further prioritisation and co-ordination efforts among MS.
- Ongoing, substantial investment in providing and enhancing **connectivity** (again under RRF national plans and commonly following on from European Regional Development Fund (ERDF) investment), focusing initially on communities that are the least well served (those without, or with slow connectivity), was mentioned by a majority of MS. The issue of connectivity for some countries has been solved and for others with marked geographic, economic and demographic discrepancies, it is still a challenge.
- In all MS, the **maintenance and upgrading** of these systems will remain and important task. As with infrastructural investments, these were commonly, though not always, embedded within broader national digital education strategies or initiatives.

Challenges

One-quarter (25%) of topic instances under this theme were indicative of challenges, which is higher than the average percentage of challenges across topics (16%). MS with rankings that are lower than the EU average on infrastructure and connectivity frequently expressed the sentiment of **'a lot achieved but still a lot more to be done'**. Clearly, this reflects not only the size of investments required but also the scale and complexity of the implementation effort.

- This, first of all, raises the question of how to best support MS with less well-developed digital infrastructure and connectivity ecosystems to accelerate in a manner that does not result in reform overload or fragmentation. Indeed, some MS also raised the issue that primary schools are under local responsibility, hence the government cannot oblige the use of tools or instruments provided - including internet. The lack of coverage in some areas was also raised by some MS.
- Second, while some MS have (or shortly will have) systems in place to track school/institutional device/infrastructural investments in schools/institutions, several MS noted that it was a challenge to monitor these investments due to a lack a national/regional system to track the use of equipment. In a few MS, there were difficulties in centrally auditing school devices and equipment.
- Third, a 'services gap' referred to by a small number of MS for local school network maintenance: frequently, network services serve schools from outside. When schools report problems on their networks, this is often related to issues with the local network inside the school. In the absence of a dedicated IT support staff for schools, this gap can be quite disruptive to schools' effective use of digital technologies (where IT services may be lost completely until an IT support person can visit the school). This 'services gap' is also linked to the infrastructure and connectivity topic.
- Finally, the challenge of sustaining and maintaining devices and other elements of infrastructural investments commonly arose, and this issue was expressed in three aspects. The first is that MS that do not have digital coordinators to support schools report challenges in terms of technical maintenance and support for school staff. In many cases, this support is delegated to school staff who do not have the knowledge, skills or time to sustain this role. The second aspect is that, in a few

of the SD, MS authorities expressed the need to incorporate device and equipment refurbishment and recycling in their digital education infrastructure planning. Third, in some MS, the lack, or early stages in, implementation of whole-government approach appeared as a related challenge to the second issue, where difficulties in obtaining Finance Ministry support for investment in connectivity for schools.

3.2.2.2 Digital content, tools and platforms

Themes

In the SD discussions on this topic (which emerged in 26 MS and accounted for 19% of topics), about three-fifths of the commentary on this topic referred to primary and secondary schools, with the remainder spread across Higher Education and VET.
Recent and current initiatives (commonly in combination) include:

- Platforms that give access to **digital educational content** to support teaching, learning and assessment activities, with these developments frequently linked to national/regional curricular reforms
- Platforms that facilitate schools' day-to-day **administrative and communication activities** (internally among staff, staff and students, with parents, etc.)
- **Remote/blended** teaching and learning platforms
- Investments in elements of the ecosystem that facilitate **interoperability** between legacy systems, or which enable new interoperability to function
- Development of new digital teaching and learning content and tools, and/or digitalisation of teaching and learning materials
- Teaching and learning content/tools for **emerging technologies** such as AI, IoT, and big data analytics
- **Open education resources**, some of which were targeted at a general level, others being targeted more specifically at groups and/or digital skills areas
- **Self-assessment tools** (such as SELFIE and SELFIEforTEACHERS) for use by teachers, students, school leaders, and citizens more generally
- Digital competence **frameworks** and **guides** (such as DigComp, DigCompEdu and DigCompOrg) for use by teachers and school leaders.

It is evident that MS are at different stages of implementation. An emerging trend with respect to digital content, tools and platforms is that significant efforts and investments are being made to create and sustain integrated platforms that provide educators and students with a single login or entry point to a range of pedagogical, administrative (including monitoring) and pedagogical functions. Frequently, these efforts gave rise to discussions in the SD meetings of about interoperability, data security, legacy/transition, co-ordination and sustainability, as described below. Also relatively common were requests from MS authorities for support in content development (best practice sharing and content sharing).

Challenges

The percentage of challenges under this topic (7%, across six MS) was lower than the overall average across topics (16%). Four key challenges emerged in the area of digital content, tools and platforms:

- First, MS raised concerns about the ability of schools and other educational institutions to meet GDPR[503] obligations (given the large amounts of data now under the responsibility of schools as data controllers) and to ensure cybersecurity of their systems and users (particularly given recent trends towards cloud-based and integrated tools and services). These are areas for which support at the level of the EU was sought (as described later).
- Second, MS described the inherent level of complexity in the digital ecosystems of their education systems, citing challenges in implementing digital platform solutions in particular. While many MS were working to overcome these challenges, others are currently operating within a landscape that is more fragmented for a variety of reasons including legacy issues and education system

[503] The General Data Protection Regulation, which came into effect in May, 2018 (https://gdpr.eu/what-is-gdpr/).

decentralisation. Several MS sought EU-level support in overcoming interoperability challenges relating to digital platforms.

- Third, concern was expressed among some MS about the timing and pace mismatch between updating curricular and other pedagogical content and rapid changes in digital technologies.
- Finally, a small number of MS expressed the view that Higher Education was not currently integrating digital content and tools sufficiently to fully develop and exploit digital skills and their potential among staff and students.

3.2.2.3 Networking and collaborative supports and activities

Themes

Almost all MS (24 of the 27) described implementing multiple networking and collaborative initiatives to support an enabling ecosystem for digital education (and these descriptions accounted for 8.5% of all topic instances). Many referred to existing actions which are currently being developed or enhanced following the learnings and experiences of the pandemic. They cover a range of activities which cut across levels of the formal education system and which operate variously at local, regional and national levels. A little over half of the initiatives identified in the SD documentation were targeted at primary and secondary levels of the system, with the remainder split across Higher Education and VET or to a combination of VET with other parts of the education system.

Commonly-mentioned networking and collaborative supports and activities were:

- **Collaborative networks** of and for school leaders and teachers (including Communities of Practice). The purpose and function of these networks varied, but most commonly enabled peer learning and supports for leadership, teaching and learning in relation to digital education and digitisation.
- **Various co-ordination supports,** for example to enable schools to work together to purchase equipment, or through regional IT co-ordinators to provide supports in planning and implementation of schools' digital education plans and/or technical support and assistance.
- Structures and activities that are designed to **enable stakeholder and social partner involvement** in strategy development and implementation.
- **National or regional fora** to facilitate discussion and shared learning on digital ecosystem issues.

We identified two emerging trends:

- First, several MS described a new dedicated support role for schools. This role is given a variety of titles, such as ICT co-ordinator, digital guru, or ICT support staff. Many MS are recognising that such support needs to include more than technical support and maintenance, since school leaders and educators also need *strategic* guidance and support for their schools' digital plans, as well as *pedagogical* guidance in the use of digital tools in teaching, learning and assessment.
- Second, some MS have integrated these activities into a broader digital education strategy. In contrast, in other MS, these activities appear to be of a more bottom-up nature. The extent to which these activities are strategically integrated and developed within a broader policy framework is therefore unclear in some MS.

Challenges

There were few challenges associated with this topic (2% compared to the overall average of 16%), though a small number of MS expressed a desire to enhance networking and collaboration activities across the formal educational system, particularly across primary and secondary levels.

3.2.2.4 ITE and CPD, digital pedagogy

Themes

A large majority of the commentary from all 27 MS on ITE (Initial Teacher Education) and CPD (Continuing Professional Development) (15%) of all topics related to primary and secondary levels of the education system,

with much less emphasis on supporting the development of digital pedagogies among educators in the Higher Education or VET sectors.

The following emerged as relatively common themes regarding **CPD**:

- During the pandemic with the sudden shift to distance learning, the difficulty for a large number of teachers to cope with the new conditions became clear and a digital training effort was launched. Building on the learnings of the pandemic, many MS have, or are in the process of, implementing educator CPD at a large scale, using online tools, often in combination with other techniques (e.g. face-to-face training, digital platforms to enable collaborative exchange).
- It was not uncommon for MS to implement CPD programmes for educators that combined digital education pedagogies (embedding digital technologies in teaching and learning) with digital skills (to enhance the digital competences of educators) (the latter is discussed under Section 4). However, in a few MS, the focus appears to be largely on digital pedagogies.
- Just a few countries were also implementing programmes specifically targeted at school or institutional leaders, in order to enable them to support the development of digital pedagogies among teaching staff and to support the digital transformation of schools more generally. However, overall, commentary was largely focused on teachers, with just a handful of instances referring to CPD for school leaders or a mixture of teachers and school leaders.
- A small number of MS referred specifically to DigCompEdu as a useful framework for developing teachers' digital pedagogical skills and learning pathways.

A majority of MS indicated that **ITE** included a mandatory or core component of digital pedagogies while there were a couple of instances which indicated that this was either non-mandatory or under review. ITE in most MS is embedded in HEIs and most of them have autonomy over their curricula and what is included in them. This means limited influence for the government to impact how digital pedagogy skills are taught in ITE.
It is noteworthy that the discussions on CPD and ITE in digital pedagogies tended not to include references to the actual or expected impact of such efforts, whether on teachers or students. Further, there were not many references across MS on the continuity of teacher training. This rather fragmented and ad-hoc nature of support for teacher learning and development may be underpinned by a range of factors, including the non-mandatory nature of CPD in many MS. Notwithstanding the value of self-reflection tools such as SELFIEforTEACHERS, the low levels of assessment or monitoring of teacher digital competences remains low (the latter is discussed under Digital Skills, Section 4).

Challenges

The percentage of topic instances identified as challenges in the analysis (22%, across 17 MS) is slightly higher than the overall average (16%).

- A key emerging challenge in the digital pedagogical skills of educators relates to a broader issue in teacher supply. This was expressed in various ways, ranging from more general references to the teacher supply issue including ICT teacher shortages or difficulties in finding qualified staff to act as IT co-ordinators (also referenced under Section 3.2.2.3 above), to more specific analysis of the problem, including difficulties in attracting younger teachers into the profession; engaging hard-to-reach school leaders and teachers (within the context of an ageing teacher population which may already be struggling with limited human resources); low salaries to attract digitally-skilled teaching personnel in comparison with the private and other sectors; and/or difficulties in attracting and retaining teachers in specific regions or communities (including rural and disadvantaged areas).
- For some MS, the provision of CPD and ITE on digital pedagogies represented a difficult investment choice, that is, whether it would be more effective to invest broadly in all educators, or to target investment to some teachers (e.g. dedicated teachers of ICT-related subjects). This choice implies a necessity to clarify the roles of teachers within the formal education system, i.e. whether some roles or all roles require digital pedagogical skills, and at which levels.
- Some MS with regional governance of their systems also pointed to challenges in obtaining a comprehensive overview of the situation, when the responsibility for teacher education and training is devolved from central Government.
- Some MS commented also on a perceived mismatch between the training offer and the needs of educators. This issue may be made more challenging by low or varied motivation of teachers, and a

need to strengthen digital leadership culture from school management, as well as the current monitoring situation, in which most MS do not currently have a means to assess or monitor teachers' digital pedagogical skills (or digital skills) in order to diagnose and address needs. While it is acknowledged by some MS that international studies such as TALIS and ICILS provide valuable insights into the education system, these sources do not provide the required information for matching training offer to need.

- We can also observe that the relatively low focus on CPD in the VET and Higher Education sectors relative to primary and secondary levels may merit further attention, at least to assess the current and emerging needs of educators in these parts of the education system.

Regarding ITE, the two key challenges related to:

- increasing enrolments in these courses against stiff competition for more attractive ICT career paths (discussed in more detail in Section 4, under digital skills ITE); and
- the need, as expressed in a small number of MS, to further improve the ITE training offer and make implementation more consistent as it relates to digital pedagogies. As noted previously, universities tend to have autonomy, resulting in challenges in directly influencing Higher Education strategies with regard to the number of ITE course places or attracting students to ITE courses.

3.2.2.5 Equity, inclusion and wellbeing

Themes

Within the topic of equity, inclusion and wellbeing, which featured in 26 of the 27 SD and accounted for 15% of topic instances, the initiatives and actions described by MS were spread across three main groups: disadvantaged or vulnerable individuals/communities; special education (which was also discussed under infrastructure, connectivity and equipment [assistive technologies]); and broader initiatives at primary and secondary level which included a focus on equity and inclusion. In these descriptions, MS frequently cited existing evidence to contextualise the initiatives, but detail on intended outcomes and impacts of these initiatives tended to be lacking.

These initiatives may be described in three broad categories:

- **Targeted** investments of devices and infrastructure, prioritising remote and disadvantaged communities and individuals;
- Digital content and pedagogies for learners with **special educational needs**;
- **Tailored** educational programmes and supports designed to promote and support digital inclusion of priority groups, commonly within broader social inclusion programmes (e.g. to reduce early school leaving or provide broader educational supports in a rural community).

Challenges

Similar to the average percentage of challenges across all topics (16%, spread across 14 MS), 15% of the commentary under this topic was classified as a challenge. The key issue within the topic of equity, inclusion and wellbeing relates mainly and firstly to **widely-expressed concerns about the digital divide**. MS expressed concerns about disparities primarily in terms of digital infrastructure and access of individuals living in urban and rural/remote areas and in more and less disadvantaged communities, including migrants, refugees and specific ethnic groups such as the Roma. MS expressed this both in terms of the infrastructure of homes as well as schools and educational institutions. It is clear that, despite or even perhaps because of the pandemic (with substantial investments, efforts and new awareness), MS recognise the need to address the digital divide as it is manifested in various ways in individual contexts. Indeed, several MS cited findings that indicate that the pandemic has, in some ways, further exacerbated and/or further exposed the existing digital divide. In the discussions, several MS authorities expressed a need to understand the challenges faced by different groups and how to make systems more inclusive.

In expressing these concerns, it is clear that MS are continuing to invest financial and human resources to tackle the digital divide. However, from the evidence emerging in the structured dialogue thematic analysis, MS need more support in targeting investments to support equity and inclusion within the digital education ecosystem and in monitoring the impact and effectiveness of such efforts.

Secondly, a few countries expressed concerns about the **digital wellbeing of students**, and cited examples of initiatives designed to promote safe and healthy use of digital technologies and cope with cyberbullying. These concerns, which were more widespread than initiatives to tackle them, suggest a need to address digital wellbeing needs of MS' education systems in a more co-ordinated manner.

Some MS also mentioned the new and additional concerns and challenges emerging as a result of the crisis in **Ukraine** (for example, the additional human resources to support these children and their parents), where it should be noted that MS are differentially affected by this crisis.

3.2.2.6 Monitoring, evaluation, assessment

Themes

Monitoring, evaluation and assessment activities were quite widely referenced in 26 of 27 MS, covering 18% of all topic instanced) and discussed in the SD meetings, reflecting both EC priorities and the priorities and concerns of MS officials. Efforts are largely focused on primary and secondary levels of the education system. The most common forms of monitoring, evaluation and assessment activities are described below.

- A little over half of MS mentioned monitoring activities within the broader implementation plans of their national strategies, and it was common to have external quality assurance mechanisms (e.g. via an Inspectorate). While all MS expressed an awareness of the importance of monitoring enabling factors, MS are at very different stages of doing so. While, in a small number, monitoring systems are well-developed and new and innovative enabling factors indicators are under development, other MS have a more ad-hoc and fragmented approach to monitoring (as described under Challenges, below). Indeed, the varying, and frequently the absence of, descriptions of impact evaluation of digital ecosystem investments, indicate that MS are at varying levels of development in their implementation of impact evaluation.
- Governance or regulatory activities: these included, as examples, the introduction of digital workplans in a number of countries, requirements for schools to have a digital education plan in place in order to receive funding, and performance agreements with HEIs to regulate digital resource funding.
- Use of self-assessment tools by schools (e.g. SELFIE) and/or teachers (e.g. SELFIEforTEACHERS) were present in about half MS SD documentation. MS which reported using these tools spoke positively about them, though in a majority, their use tended to occur in a bottom-up fashion, and some MS sought support to further integrate the use of these tools more formally or extensively in monitoring and evaluation activities. Some MS also indicated that, with the change of curricula (and ICT being included), tests would support the monitoring process, with some viewing this as a reason not to further develop monitoring systems.
- In a small number of MS, comprehensive systems to monitor school device usage were already in place, while in a few others, these systems were under development. Although some form of system-level data collection for monitoring purposes was widespread, the collection and usage of system-level data for this purpose appears to vary widely.
- About two-thirds of MS referred to large-scale international assessments such as ICILS, PIAAC, PISA and TALIS to monitor the state of play in their digital ecosystems. This suggests that MS appreciated the added value of participating in international comparative studies, though as noted elsewhere, some acknowledged that these studies cannot address all national monitoring and evaluation needs and that supplementary national data collection and monitoring activities are needed.
- Finally, process evaluations of enabling factors were also mentioned: these tended to refer to specific national evaluation studies of programmes or initiatives, such as national surveys of teacher and student usage of digital technologies for teaching and learning.

Challenges

Challenges in monitoring, evaluation and assessment were relatively high (28% compared to an average across topics of 16%, spread across 20 MS) and may be grouped under three themes, which show a strong relationship with governance (see Section 3.2.2.10 below):

- Achieving a whole-of-government, systemic approach; the ability to link the various elements of strategies and enablers together (i.e. infrastructure, standards and curricular adjustments, content and

training). This is related to the complexity and effort required in a whole-of-government strategy co-ordination and monitoring, in which regional governance adds an extra layer of complexity, and is exacerbated by gaps in the monitoring system, and challenges related to data and interoperability.
- Matching the digital ecosystem to the needs of individual schools: this entails tailored and agile approaches. However, it should be noted that a small number of MS have reported success in achieving this complex task through the use of IT co-ordinators working with clusters of schools where a tailored approach, adapted to local needs and resulting in local capacity building: such an approach requires sustained human resources.
- Finally, reflecting the diversity of MS, the SD for many countries also indicated specific gaps in monitoring and evaluation ecosystems, three of the more commonly-mentioned being a lack of systematic monitoring of teachers' digital pedagogical skills; lack of monitoring of device usage in schools; and the current situation of an ad hoc monitoring more generally.

3.2.2.7 Research and data

Themes

There was relatively little commentary on research and data relating to enabling factors (this topic appeared in 13 MS and accounted for just 3% of topic instances), which could suggest a need for EU-level co-ordination and support of research in this area.

Two main themes emerged:

- Specific references to national research studies on enabling factors topics, such as overcoming the digital divide, online behaviour of young people, the validation of digital learning portfolios.
- Platforms and tools for the storing and dissemination of enabling factors research and data.

Challenges

No challenges under enabling factors research and data emerged. However, a majority of MS called for the EC to undertake more research and collection of evidence in relation to enabling factors.

3.2.2.8 Opportunity and Innovation

Themes

The nature of this topic is twofold (and it emerged in 16 structured dialogue meetings, covering 4% of topic instances): on the one hand, it describes the actions and learnings of MS in response to the COVID 19 pandemic, which are used to as an opportunity to enhance the digital education ecosystem. The opportunity presented by the pandemic is related to governance, engagement and partnerships (see Section 3.2.2.10 below). On the other hand, it describes innovative enabling factors initiatives among MS.

For MS with already well-developed digital education and skills ecosystems, they commented that existing platforms and solutions greatly supported efforts to respond to the crisis.

A majority of MS are using and building on the learnings of the pandemic as an **opportunity** to:

- Continue building on existing and newly-established digital infrastructure, connectivity, tools, content and platforms to further enhance the digital education ecosystem and the delivery of blended teaching and learning.
- Use the newly established lines of communication and collaboration across government, levels of the system, and with social and industry partners which had arisen in response to the crisis, to continue to build the digital ecosystem in targeted ways (e.g. decentralisation reforms).
- View and harness EdTech development and public-private partnerships as a strategic means to enhance the digital education ecosystem.

Regarding **innovation**, an array of innovative activities were described by MS in the SD. These included:

- New and innovative programmes that include digital ecosystem enabling factors, such as innovative school leadership, incorporation of AI into teaching, learning and assessment CPD and tools, and the development of a system for the quality assurance of EdTech teaching and learning apps.
- Investments to encourage the development of content and solutions to support new and emerging technologies.

Challenges

Apart from the significant challenges that had emerged with the onset of the pandemic, MS did not raise any challenges relating to opportunity or innovation.

3.2.2.9 EU support for enabling factors

Suggestions for support at the EU level were provided by 23 of the 27 MS. Main themes are summarised below.

- Many MS called for support at the EU level in the conducting of research and gathering of evidence in relation to enabling factors, perhaps indicating a recognition of developing objectives reflecting optimal targets, and the overall complexity of the topic.
- A majority of MS wanted more opportunities to exchange best practices with one another on:
    - enabling factors for digital ecosystems, including ecosystems that successfully reach remote and vulnerable groups;
    - CPD and digital content and solutions for digital pedagogies;
    - the use of tools and frameworks (such as DigComp and SELFIEforTEACHERS) to support CPD and educator self-assessment and monitoring;
    - models for the provision of technical support and maintenance to schools;
    - Higher Education modernisation and reform initiatives; and
    - the sharing of solutions to some of the technical challenges associated with the digital education ecosystem (e.g. interoperability).
- Further funding supports relating to infrastructure and connectivity and advice on efficient and effective funding of these were sought. Many MS were of the view that further funding is required for this aspect of their digital ecosystems, highlighting in particular connectivity in general, and hardware for Higher Education.
- Some MS expressed a desire for the EU to strengthen its co-ordination and regulatory activities in a range of digital ecosystems enabling areas, including:
    - the use of common language/terminology and standards in the general area of digital education
    - further alignment and connections of various digital ecosystem enabling initiatives within and across EU institutions
    - stimulation of partnerships with EdTech while at the same time supporting regulation of the EdTech industry (e.g. data privacy, data ownership)
    - regulations and supports for interoperability at European level
    - monitoring Higher Education digitalisation strategies; and
    - data privacy policy consolidation (including exchanges between MS and the European Data Protection Board).
- Several MS sought technical support from the EC to address data privacy (particularly as this relates to schools and educational institutions in their new role as [GDPR] data controllers, where the sheer volume and interconnectedness of data is difficult to manage), digitalisation of Higher Education, and in finding solutions for updating of curricular and other pedagogical content to keep pace with changes in digital technologies.
- A few MS referred specifically to DigComp seeking better harmonisation or alignment in the use of DigComp across MS.

3.2.2.10 Governance, engagement and partnerships

At the 'top tier' of governance, and recognised as a key factor in enabling the successful development and implementation of digital education and/or skills policies are the national and regional structures that enable whole-of-government approaches to policy development and implementation.

The main challenges relating to engagement and partnerships were articulated with respect to implementing whole-of-government approaches to policies on digital education and skills. A majority of MS were experiencing challenges in this regard, and the SD discussions on this theme indicate particular difficulties with the policy implementation and monitoring phases (as already noted in the section on monitoring, evaluation and assessment).

While a majority of MS are moving towards or already implementing whole-of-government approaches to digital education and skills policies, an emerging finding is that the co-ordination efforts are experienced as very challenging and frequently technically complex, in particular at the implementation and monitoring stages. Indeed some MS noted challenges in the demarcation between operational programmes. There was variation across MS with respect to the number of distinct digital education and skills policies and strategies in place, and it is common for MS to have a high number of distinct strategies. However, an emerging trend is for overarching strategies which incorporate sub-strategies, in line with whole-of-government approaches to policy more generally. Another challenge with respect to co-ordination and implementation relates to co-ordination across government levels, particularly in MS with regional governance structures and high levels of local autonomy. Some MS noted the need to strengthen links with industry and between sectors, where collaboration between VET, Higher Education and industry were at the early stages.

Actions and initiatives which incorporated engagement between actors in the digital education ecosystem appeared in about one-third of topic instances and across all 27 MS, reflecting widespread engagement practices at various levels of the digital education ecosystem.

A majority of engagement practices reflected engagement among public actors within the education and employment sectors, very frequently with social partners (including unions, teacher representative bodies and inclusion actors) on issues relating to digital education, and in some cases, e.g. Higher Education, cross-institutional engagement on digital education enablers (e.g. interoperability).

In a majority of MS, the SD documentation described engagement between education and industry sectors as part of digital education strategy implementation. Engagements also occurred at other levels within sectors. These included initiatives to build links between the two; there were also a few examples of public-private engagement on digital education policies and initiatives via national fora or other enabling infrastructures.

A little under one in ten actions and initiatives referenced partnerships, and these appeared in the SD documentation of about two-thirds of MS. The most frequently mentioned partnerships referred to networking and collaborative supports or activities targeted at primary and secondary levels (but a few also including VET and Higher Education), where schools or educators worked in partnership with one another for peer-to-peer knowledge sharing or for a common purpose such as the purchase of school infrastructure. Very few of these comprised public-private partnerships. Those that were discussed include the co-creation or co-development of digital content or solutions or in the co-funding of infrastructure or devices.

Challenges were expressed by some MS in involving all stakeholders in digital education and skills reforms, particularly in MS with regional governance arrangements, and several MS cited challenges in engaging educators to participate in CPD. Several MS expressed a desire to stimulate more public-private partnerships, in particular with the EdTech sector, to strengthen the digital education ecosystem, and some recognised the potential of EdTech to make significant contributions through partnerships. In doing so, some concerns were expressed about the need to regulate the influence of EdTech on the education sector, particularly in Higher Education.

3.2.3 Summary of findings from the Structured Dialogue

Two groups of enabling factors emerged from the analysis of SD documentation. These are **foundational enabling factors** – infrastructure, connectivity and equipment; digital content, tools and platforms; networking/collaborative supports/activities; and ITE and CPD for digital pedagogy; and enabling factors that provide **direction, structure and value** for successful digital education – equity, inclusion and wellbeing; monitoring, evaluation and assessment; research and data; and opportunity and innovation.

The SD discussions highlighted challenges relating to monitoring, evaluation and assessment; equity, inclusion and wellbeing; ITE and CPD for digital pedagogy; and infrastructure, connectivity and equipment.

Infrastructure, connectivity and equipment are being prioritised across a large majority of MS. Emerging trends, building on the learnings of the pandemic were that:

- large-scale investment in devices, commonly within the broader digital education strategy are taking place, and, consistent with RRF national reports, there is ongoing and substantial investment in improving connectivity;
- specific measures targeted at disadvantaged learners commonly include the provision of free devices (and sometimes within universal free provision of devices for learners);
- where device targets are specified, these refer to one device per learner from the upper primary level to secondary level, and one device per four or five students in lower primary (noting that in some MS the provision of devices to learners entails the use of tablets among younger age groups and devices with keyboards among older age groups); and
- assistive technologies were not widely referenced in the structured dialogue meetings, suggesting that this is an issue that may merit further attention.

Variation in coverage within regions of MS is apparent. Two main challenges emerged with respect to infrastructure, connectivity and equipment: a majority of MS do not yet have a system to track the use of digital equipment (and some MS lack an audit system for devices and equipment); and secondly, some MS expressed concerns about the maintenance of equipment, devices and/or connectivity (in terms of refurbishment/recycling, lack of human resources to provide technical support and maintenance to schools, and, in a broader sense, difficulties in obtaining Finance Ministry support for investment in connectivity for schools).

MS are making significant efforts to support their digital education ecosystems through a range of **content, tools and platforms**, building on work that began with the onset of the pandemic. An emerging trend is the development of integrated platforms that provide educators and students with a single entry point. This, however, can give rise to complex technical challenges.

Three key concerns were raised in the SD discussions about content, tools and platforms:

- challenges for schools and other educational institutions to meet GDPR obligations;
- complex interoperability and legacy platform system challenges; and
- challenges in matching the pace of technological change with updated teaching and learning content and tools.

Almost all MS described implementing multiple **networking and collaborative initiatives** to support an enabling ecosystem for digital education. An emerging trend is a dedicated support role for schools. Many MS are recognising that such support needs to include both technical support and maintenance as well as digital pedagogy and strategic planning. Several MS noted a desire to further enhance existing collaborative networks across levels of the education system.

Regarding **CPD and ITE for digital pedagogies**, many MS are in the process of implementing CPD at a large scale, building on the learnings from the pandemic, and frequently combining both digital skills training for educators with enhancing their digital pedagogical competences. While participation in CPD is monitored in a majority of MS, there was much less focus on its impact. CPD programmes for education leaders were mentioned in some SD discussions but were less widespread than CPD for teachers, and the focus on CPD generally was at primary and secondary levels rather than VET and Higher Education. A few MS specifically referenced DigCompEdu, expressing the view that it was a useful framework for developing teachers' digital pedagogical skills and learning pathways. Where ITE was discussed, most indicated that ITE included a mandatory or core component on digital pedagogies.

Challenges in relation to CPD were discussed in 17 SD meetings. Concerns were frequently expressed in relation to the broader issue of teacher supply. Difficulties in attracting teachers to the profession and engaging teachers to participate in CPD were also mentioned. At times this could lead to difficult investment choices, reflecting a tension between CPD for all teachers and CPD for a specific sub-group of teachers (this suggesting in turn a need to clarify or specify different teacher roles). Some MS commented also on a perceived mismatch between the training offer and the needs of educators which could be exacerbated by low or varied motivation

of teachers, and a need to strengthen digital leadership culture from school management, and the fact that many MS do not currently have a means to assess or monitor teachers' digital (pedagogical) skills. Challenges concerning ITE focused on increasing enrolments in these courses in the context where HEIs, the primary source of ITE courses, are relatively autonomous, and where other courses may be more attractive in terms of labour market and salary prospects.

Descriptions of **equity, inclusion and wellbeing** initiatives fall into three broad groups: investments targeted at disadvantaged communities, programmes tailored to disadvantaged or vulnerable groups, and digital content and pedagogies to meet special educational needs. Just over half of MS (14) expressed concerns about the digital divide, recognising it as an issue with multiple causes and manifestations, and some MS noted (consistent with the research evidence) that concerns about the digital divide had increased following the onset of the pandemic. MS authorities expressed a need for more support in targeting investments to support equity and equality with regard to digital education, as well as in monitoring the impact and effectiveness of such efforts. Concerns were also expressed about the digital wellbeing of students. This could suggest a need to address digital wellbeing needs of MS' education systems in a more co-ordinated manner.

While all MS expressed an awareness of the importance of **monitoring, evaluating and assessing** enabling factors, MS are at different stages of doing so. While monitoring systems are well-developed in a small number of MS, many have a fragmented or ad-hoc approach to monitoring. It was common for MS to describe challenges in achieving an integrated and systematic approach. Further, in some MS, collaboration between sectors, notably especially VET, Higher Education and industry were at the early stages. The use of self-assessment tools such as SELFIE were referenced by several MS; however, there were also some calls for support to further integrate the use of these tools in monitoring and evaluation activities (that is, integrating existing bottom-up approaches in the use of these tools with top-down approaches).

There was relatively little commentary on **research and data** relating to enabling factors, which could suggest a need for EU-level co-ordination and support of research in this area. Indeed, a majority of MS called for the EC to undertake more research and collection of evidence in relation to enabling factors.

A majority of MS are using and building on the learnings of the pandemic as an **opportunity** to continue building on existing and newly-established digital infrastructure, connectivity, tools, content and platforms; use newly-established lines of collaboration and communication; and harness EdTech developments and public-private partnerships. Regarding **innovation**, several innovative activities were described by MS in the SD. These included new and innovative teaching/learning and assessment programmes and the development of content and solutions to support new and emerging technologies.

A clear emerging trend is the adoption by a large number of MS of **whole-of-government** approaches to digital education and digital skills policy development and implementation. However, a majority of MS found these co-ordination efforts challenging across departments, levels and with stakeholders, particularly at the implementation and monitoring phases, and many MS have multiple national strategy and policy documents relating to digital education, which could be both a symptom and a cause of challenges in implementing whole-of-government approaches.

Another emerging trend was the recent increase in **EdTech** activities and many MS officials recognised the potential of working with the EdTech industry to further improve or enhance digital educational infrastructure, tools and content (and there are a small number of examples of successful partnerships between Governments and the EdTech industry); nonetheless, in some MS concern or uncertainty was expressed in terms of managing regulatory aspects of the EdTech industry and/or the influence that EdTech may have on education systems.

Key areas for which **advice or support from the EU** (mentioned in 18 SD meetings) with respect to enabling factors were:

- Support at EU level in the conducting of research and gathering of evidence in relation to enabling factors
- Funding support relating to infrastructure and connectivity
- Technical and operational advice or support concerning data privacy and updating of pedagogical content.

MS also sought more **opportunities to exchange** best practices with one another in a range of areas including:

- Reaching remote and vulnerable groups
- CPD, digital content and solutions for digital pedagogies
- The use of tools and frameworks
- Models for the provision of technical support
- Higher Education reform and digitalisation initiatives
- Sharing of solutions to technical challenges (e.g. interoperability).

The SD discussions included calls for the EC to strengthen its **co-ordination and regulatory activities** in a range of areas, including

- Awareness-raising and use of common language/terminology and standards in digital education
- Further alignment and connections of various initiatives within and across EU institutions
- Stimulation of partnerships with EdTech
- Regulation of the EdTech industry
- Regulations and supports for interoperability
- Monitoring Higher Education digitalisation strategies
- Data privacy policy consolidation
- Harmonisation or alignment in the use of DigComp.

3.3 Enabling factors in the submissions to the Call for Evidence

This section considers the themes emerging from the submissions to the CfE on enabling factors for digital education. Similar to the previous two sections, an overview of topics is first provided. This is followed by a description of the main themes emerging from the qualitative analysis. Finally, we provide a summary of key findings.

3.3.1 Topic analysis overview

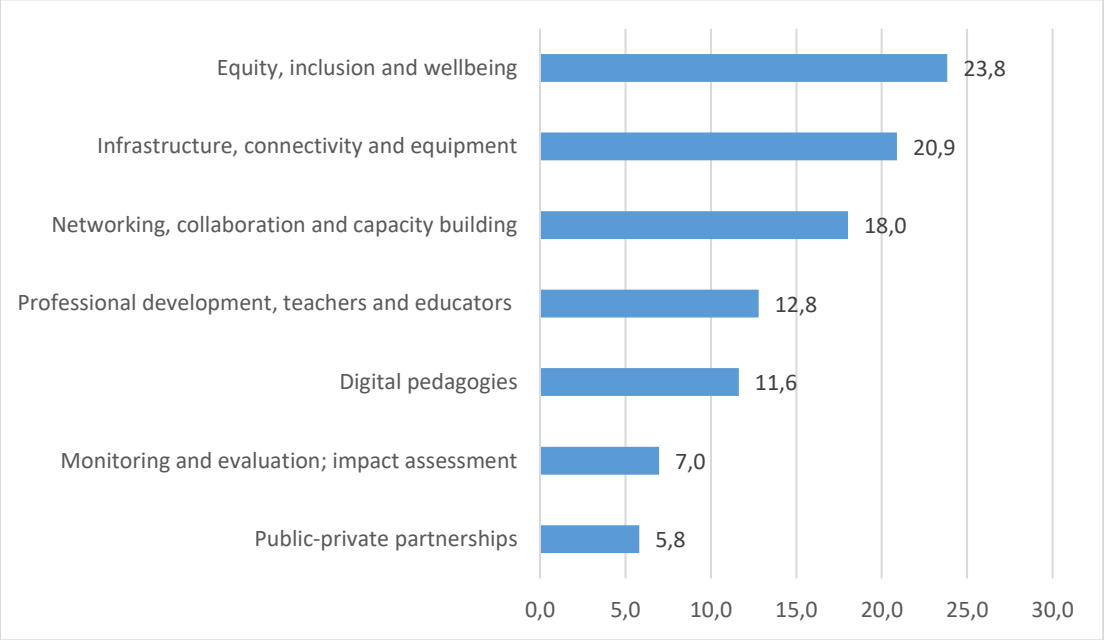
Table 3.5 provides a description of each of the topics that emerged from the submissions to the CfE, while Figure 3.2 shows the frequencies of topics across submissions.

Almost one-quarter (24%) of the topics identified concerned equity, inclusion and wellbeing. Also relatively frequent were: networking, collaboration and capacity building (18%), infrastructure, connectivity and equipment (17%), professional development of teachers and educators (13%) and digital pedagogies (12%). On the other hand, commentary on cybersecurity and data protection (4%), public-private partnerships (6%) and monitoring and evaluation/impact assessment (7%) were less frequent.

Table 3.5. Description of topics emerging from the analysis of the Call for Evidence on enabling factors

Topic	Description
Digital pedagogies	Views and perspectives on digital pedagogies (including their role in education more generally)
Equity, inclusion and wellbeing	Views and perspectives on equity, inclusion and wellbeing in the digital education ecosystem
Infrastructure, connectivity and equipment	Comments about infrastructure, connectivity and equipment (including some references to tools and platforms)
Monitoring and evaluation; impact assessment	Views on the role of monitoring, evaluation and impact assessment in the digital education ecosystem, including whole-of-government approaches
Networking, collaboration and capacity building	Views emphasising the importance of collaborative activities to support digital education, including across individuals, institutions, sectors, Government departments and MS
Professional development, teachers and educators	Views on the professional development of educators to support the digital education ecosystem
Public-private partnerships	Comments on the place of public-private partnerships in the digital education ecosystem

Figure 3.2. Frequencies of topics emerging in the submissions to the Call for Evidence on enabling factors



Of interest is the relative emphasis given to the various topics, depending on stakeholder group. This is shown in Table 3.6, using 'heat' colour coding to illustrate topics with higher (orange to red) and lower (yellow to green) levels of emphasis across stakeholder groups.

Table 3.6. Distribution of enabling factors topics in the submissions to the Call for Evidence on enabling factors by stakeholder group

Topic	*Academic/ research Institution*	*Business association*	*Business/ Company*	*Individual*	*Non-profit or non-government organisation*	*Public Authority*	*Trade union*	*Other*	**Total**
Equity, inclusion and wellbeing	13.3	15.0	11.8	14.3	40.7	11.1	10.0	30.8	**23.8**
Infrastructure, connectivity and equipment	16.7	35.0	29.4	28.6	16.9	11.1	10.0	23.1	**20.9**
Networking, collaboration and capacity building	40.0	10.0	11.8	7.1	13.6	44.4	10.0	7.7	**18.0**
Professional development, teachers and educators	13.3	15.0	11.8	14.3	8.5	11.1	30.0	15.4	**12.8**
Digital pedagogies	10.0	10.0	5.9	35.7	6.8	11.1	20.0	15.4	**11.6**
Monitoring and evaluation; impact assessment	6.7	0.0	17.6	0.0	6.8	11.1	10.0	7.7	**7.0**
Public-private partnerships	0.0	15.0	11.8	0.0	6.8	0.0	10.0	0.0	**5.8**
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	**100.0**

The table shows differences in the relative contributions of stakeholders, which is to be expected, given their different perspectives within the digital education ecosystem. For example:

- Equity, inclusion and wellbeing were emphasised to a relatively high degree in submissions from non-profit and non-government organisations
- Academic/research institutions and public authorities placed a relatively high emphasis on networking, collaboration and capacity building
- Business associations, businesses/private companies and individual submissions placed a relatively high emphasis on infrastructure, connectivity and equipment
- Trade unions placed a relatively high emphasis on professional development of teachers and educators.

3.3.2 Themes emerging from the Call for Evidence analysis

In this section, we discuss the themes emerging within each of the topics, in order of frequency (from most- to least-frequently mentioned topic).

3.3.2.1 Equity, inclusion and wellbeing

The commentary in relation to equity, inclusion and wellbeing mentioned accessibility as both a priority and a concern, emphasising the need to allocate funds to accessibility efforts (e.g. accessible learning content, accessibility standards) and to raise awareness of technologies to support accessibility. Some of the comments referenced an accessible learning environment, describing a holistic perspective on this issue.

A second theme emerging under this topic consisted of concerns about disadvantaged students and their families, with various suggestions provided for their inclusion and support, including provision of devices, direct engagement with students to hear their views, and the investment in educators in non-formal education and training settings.

A third theme related to digital wellbeing, where submissions emphasised the need to educate young people or otherwise minimise the potential harmful effects of technology (e.g. cyber-addiction, or, in a few instances, exposure to Radiofrequency Electromagnetic Fields [RF EMF]).

Fourth, a small number of submissions referred more generally to the adoption of rights-based or value-driven approaches that reflect diversity.

There was also concern expressed about the potential for digital technologies to result in the withdrawal of existing (non-digital) resources and supports within the education system, with commentary reflecting the view that digital technologies are tools that should be used to support and enhance existing resources, not replace them.

3.3.2.2 Infrastructure, connectivity and equipment

Commentary on this topic covered two main themes: the need to improve the digital infrastructure of education and training systems, with several comments advocating the provision of devices to learners; and the need for further investment in infrastructure and connectivity.

A third emerging theme indicates a tension between public education systems and private entities, particularly EdTech and large technology corporations. We saw under this topic the concept of digital sovereignty to protect against the influences of 'tech giants', and suggestions to develop an alternative teaching and learning platform for digital education and skills. This tension is also reflected in some commentary stating that education systems should serve their own needs rather than the needs of industry.

Finally, some of the commentary on this topic concerned data protection and data privacy. Commentary referred to the importance of further incorporating 'privacy by design' and 'security by design' in the development of digital educational platforms and tools. There were also calls in the commentary for more support and co-ordination at the EU level regarding the handling of personal data. Privacy by design and security by design concepts tended to coincide with commentary on interoperability, suggesting that a single overarching set of guidelines could potentially cover these various technical and operational features of platforms and systems.

3.3.2.3 Networking, collaboration and capacity building

The first theme to emerge under this topic relates to comments directed at the level of the EU. These consisted of suggestions for actions at EU level to enable MS to enhance their national digital education ecosystems, and included:

- the development of an EU framework and/or protocols on interoperability, and further investment in interoperability;
- development of data privacy standards relating to digital(ised) education data;
- guidelines on the ethical use of AI and on the recognition of non-formal learning;
- development of an EU-wide repository of digital pedagogical content and an EU-wide platform for digital education (where the concept of European digital sovereignty was mentioned);
- EU-level engagement with private actors to achieve better value for money on digital content;
- standardisation of educational data at EU level; and
- encouragement to build on research already occurring at EU level).

The second theme referred to the need to foster effective collaboration among MS and for more opportunities and spaces for digital education actors in MS to exchange and share best practices.

Finally, a small number of submissions commented on the potential for collaboration between industry and education and training actors.

3.3.2.4 Professional development, teachers and educators

Various stakeholder groups highlighted the central role of teachers and educators within the education system, reflecting a view that there is a need to do more to recognise and support them in their role, within a complex and rapidly evolving digital landscape. Submissions highlighted a need to foster and promote teacher training; there were calls for more investment in teacher professional development; and several mentioned the need to provide incentives to encourage participation in professional development, as well as recognition of it. Some of the commentary emphasised the importance of protecting teachers against over-burden and suggested incorporating professional development into working hours. A small amount of commentary on this topic noted the importance of competence and motivation of new teachers entering the profession and, with this, the importance of including digital pedagogies as a core element of general teacher education. There was a view that professional development in digital pedagogies should be for all teachers, rather than a selection of teachers, although there was also the recognition that categorising digital education training and matching this to the different teacher roles or skills levels would be beneficial.

3.3.2.5 Digital pedagogies

In the commentary on digital pedagogies, there was a frequently expressed view that teaching and learning must be learner-centred, and therefore digital tools were seen as a means to support quality education, i.e. to be used only if it adds value to the teaching and learning practice, rather than their adoption or use being an end in itself. Commentary on this topic indicated some ambivalence concerning the role of digital pedagogies: one set of views was that the use of digital content and tools can increase students' interest and motivation, that more instructional time should be spent on ICT, and that common guidance and training on digital pedagogies should be developed. On the other hand, general disagreement with the promotion of digital education was expressed by some contributors; and a view was expressed that common guidelines on digital pedagogy at EU level would not be feasible given wide differences across MS. Reference to the subsidiarity principle under this topic reflects the important and distinct roles of national and EU-level actors in the digital education system.

3.3.2.6 Monitoring and evaluation; impact assessment

There was not extensive commentary on this topic, although some submissions reflected the recognition of the need for integration and coherence within the digital education ecosystem, with actions supported by targets and monitoring of effectiveness and inclusion.

3.3.2.7 Public-private partnerships

The relatively small amount of commentary consisted of general support for the fostering of public-private partnerships, as well as suggestions on how fostering public-private partnerships could enhance the digital education ecosystem (for example, in developing CPD for teachers and potential benefits of collaboration between public actors and educational and academic publishers). A minority of the commentary on public-private partnerships expressed concerns about over-reliance on digital platforms and tools that are privately rather than publicly financed.

3.3.3 Summary of Call for Evidence findings

In the submissions to the CfE on enabling factors, we observed differences in the relative contributions of stakeholders. For example, equity, inclusion and wellbeing were emphasised to a relatively high degree in submissions from non-profit and non-government organisations, while academic/research institutions and public authorities placed a relatively high emphasis on networking, collaboration and capacity building. Results are summarised in order from most to least frequently occurring overall.

Regarding equity, inclusion and wellbeing, the submissions to the CfE on enabling factors advocated a rights-based or value-driven approach that reflects diversity. There was an emphasis on accessibility, and concerns expressed about digital wellbeing of students.

Infrastructure and connectivity were widely recognised as important, with calls for both improvements and further investments in this area. There was also some commentary on data protection, where the notions of privacy by design and security by design were advocated, and these concepts tending to co-occur with interoperability concerns.

EU-level support was suggested in relation to interoperability, data privacy and data protection, educational data standardisation, and engagement with private actors in the digital education system. There were also suggestions that the EU support the development of guidelines on ethical use of AI, recognition of non-formal learning, along with suggestions for EU-wide platforms and digital repositories.

Regarding collaboration and partnerships, the submissions advocated for MS to exchange best practices on various themes and challenges. The fostering of public-private partnerships and collaborations between education and industry was broadly supported. However, some concern was expressed about the influence of 'tech giants' in the education system, resulting in a need to serve the interests of the education system rather than industry.

Regarding professional development of teachers and educators, the centrality of teachers' roles in the (digital) education ecosystem was emphasised. Various submissions expressed the view that there is a need to better support and recognise this central role. A few submissions recommended incentivising CPD and making it feasible for teachers to attend, e.g. during work hours. Some submissions noted that CPD in digital pedagogies should be viewed through the broader lens of CPD more generally.

In commenting on digital pedagogies, the submissions took a holistic and learner-centred perspective, advocating the use of digital tools only if they add value, and not substituting or reducing existing resources with digital ones. Some ambivalence is evident in the submissions. While some were enthusiastic about the potential of digital technologies to increase motivation or felt that more hours should be dedicated to the teaching of ICT in schools, others expressed concern about the harmful effects of digital technologies and questioned the feasibility of a common EU approach, given the broad diversity across systems.

Monitoring was referenced relatively less frequently, and commentary indicated that monitoring could be more effective within an integrated and coherent digital education ecosystem, with some emphasising the need to monitor both effectiveness and inclusion aspects of digital education.

4 Improving the provision of digital skills in education and training

This section provides a summary of the themes and issues emerging from the thematic analysis as they relate to the provision of digital skills. Similar to Section 3, the results of the RRF analysis are presented first; this is followed by the results from the SD analysis; and finally, the topics and themes emerging from the CfE submissions are described.

4.1 Provision of digital skills in RRF national plans

4.1.1 Topic analysis overview

As noted in Section 2, each sub-component of the relevant sections of the RRF national reports were classified initially as investment or reform. Then, working from a combination of pre-defined and emerging topics (whilst aiming for topic unity across RRF, SD and CfE sources) each investment and reform item was assigned one or more topics. Table 4.1 provides short descriptions for each topic, while Figure 4.1 shows the distribution of topics across investments and reforms.

In interpreting the results, recall that analysis looks at content and not on size of investment.

Table 4.1. Descriptions of topics in the thematic analysis of RRF national plans digital skills provision

Topic	Description
Legislative and governance reform	Broad legislative and governance reforms to support digital skills provision
Initiatives to boost digital skills outside formal education	Reforms or investments relating to digital skills provision outside of formal education
Initiatives to boost digital skills in education settings, including curricular reforms	Reforms or investments relating to digital skills provision in formal education settings
Equity, inclusion and wellbeing	Reforms or investments for digital skills provision targeted at specific groups including socio-economically disadvantaged persons, women, older persons
ITE and CPD, digital skills	Reforms or investments relating to initial teacher education, continued professional development of teaching staff focused on digital skills
Monitoring, evaluation, assessment	Reforms or investments relating to the monitoring, evaluation or assessment of digital skills provision
Opportunity and innovation	Innovative digital skills initiatives (e.g. in emerging technologies skills provision) or opportunities identified to build on existing digital skills provision
Research and data	Digital skills research and data activities, e.g. national research study

For **reforms**, the most frequent topics related to broad legislative and governance reforms (24%), reforms relating to digital skills provision outside of formal education (25%), and reforms to support digital skills provision in formal education settings (24%). In terms of **investments**, the most frequent topic related to digital skills provision outside of formal education (39%), followed by digital skills provision in formal education (16%) and equity, inclusion and wellbeing (14%).

Figure 4.1 also includes a category for investments and reforms of <u>other</u> topics: these comprise topics shown in Table 4.1 above for which frequencies were less than 2.5%.

We do <u>not</u> provide a separate analysis of topics with frequencies of less than 5% (rounded), since there is an insufficient number of cases to provide reliable or generalisable information.

Figure 4.1. Distribution of RRF national report topics on digital skills provision (%), by investment and reform

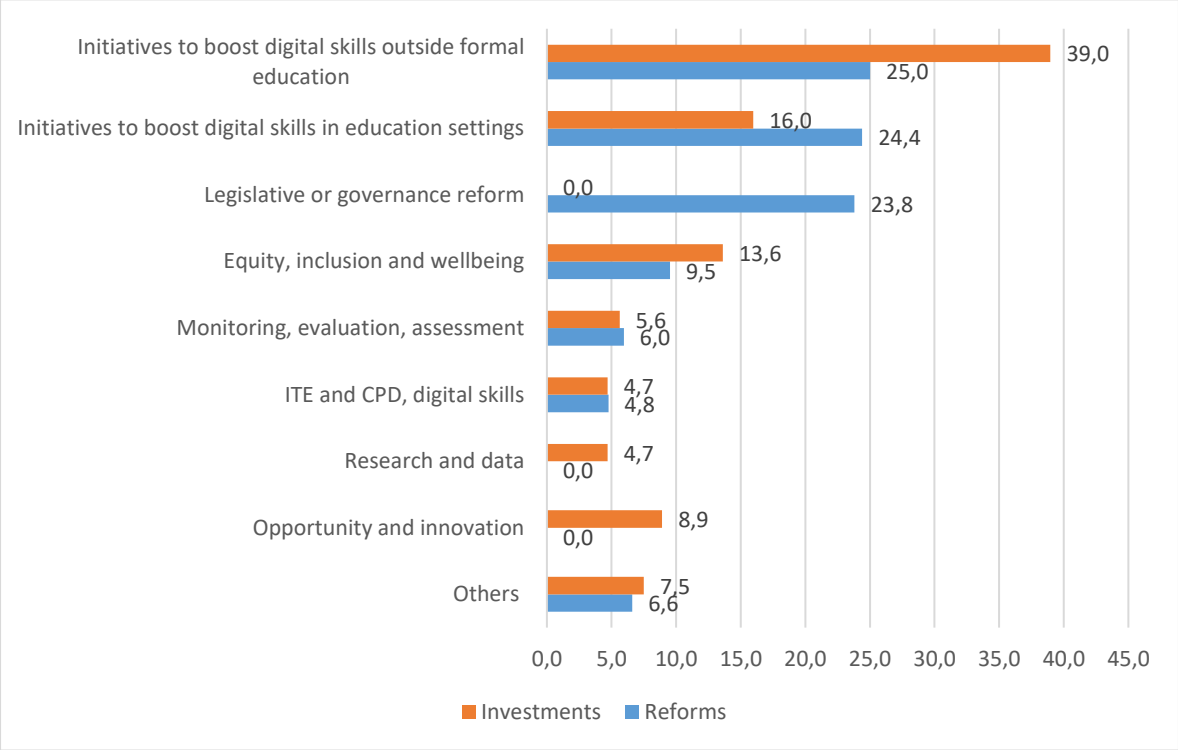


Table 4.2 shows the number of MS in which digital skills reforms and investments were mentioned. The three most frequent **reforms**, classified by topic, relate to initiatives to boost digital skills outside of formal education (19 MS); initiatives to boost digital skills in education settings (including curricular reforms) (18 MS); and general legislative or governance reforms related to the provision of digital skills (19 MS). Other topics featured in the reforms of between two and seven MS.

Largely consistent with the reforms, **investments** were concentrated on initiatives to boost digital skills both outside of formal education (21 MS) and in formal education settings (17 MS) and on equality, inclusion and wellbeing in relation to digital skills provision (17 MS). The remaining enabling factors investment topics featured in two to nine MS.

Table 4.2. Distribution of digital skills reform and investment topics from RRF national plans across 27 MS

Topic	Reforms	Investments
Legislative and governance reform	19	0
Initiatives to boost digital skills outside formal education	19	21
Initiatives to boost digital skills in education settings, including curricular reforms	18	17
Equity, inclusion and wellbeing	10	17
Research and data	2	7
ITE and CPD, digital skills	6	5
Monitoring, evaluation, assessment	7	6
Opportunity and innovation	5	9
Research and data	2	7
Others	2	2

4.1.2 Themes emerging from the RRF analysis

As already noted in Section 3.1.2, there is overlap across topics in the themes emerging. This is because multiple topics have been assigned to each sub-component. It should also be recalled from Section 2 that there is a wide variation in the number of sub-components (and hence topics) associated with each MS. The end of this section provides a short summary of main findings.

4.1.2.1 Legislative and governance reforms

Just over half of the RRF national plan **reforms** that were classified under this broad legislative and governance reform topic (in 19 MS and accounting for 24% of digital skills reform topics) consisted of broad skills-related reform or strategy development (for example, the development of a national digital skills plan, or new strategy for lifelong upskilling), with differing targets or focus. About half were targeted at the labour market, including active labour market policy reform; reskilling and upskilling reforms for SMEs, public/civil servants; and strategy development to address labour market skills mismatches; about a third related to broad skills reforms within the education system, and the remainder of these were targeted very broadly across both the education and employment sectors.

About a third of these broad reform measures specifically referenced legislative reforms, which again covered a variety of themes, including legislation to permit greater flexibility, transition, digitalisation and training in the labour market; new legal frameworks to strengthen the effectiveness of VET systems; legislative amendments targeted at Higher Education to enhance attractiveness/flexibility/competence of academic staff or merging of HEIs to larger entities to enhance advanced IT studies; and reforms to strengthen the provision and monitoring of CPD.

Of the remaining broad legislative and governance reforms, a small number were targeted at research, development and innovation, in particular to enable public-private partnerships for digital innovation, and a couple of reforms aimed at strengthening monitoring and data relating to digital skills provision.

4.1.2.2 Digital skills provision outside of formal education

As noted earlier, this was the topic with the highest frequency of investments (51.5%, across 21 MS) and was accompanied by a sizeable number of reforms (16%, across 19 MS).

A majority of **reforms** under this topic (three-quarters or so) were variously targeted at the labour market generally (e.g. active labour market policy reforms, establishment of a continuous learning and employment centre, mechanisms for public-private partnerships, or reforms to enable implementation of digital skills training vouchers/incentives); businesses and in particular SMEs (e.g. establishment of a Digital Innovation Hub, incentivisation of digital skills training); government (e.g. establishment of competence support structures, reforms to enable digital upskilling of public servants); or citizens more generally (e.g. to establish individual training accounts, regulatory framework for adult learning). The remaining quarter or so consisted of descriptions of the development or implementation of broad, national plans or strategies, such as national digital skills plans or strategies for lifelong learning.

Investments in the provision of digital skills outside of formal education were almost evenly split between initiatives for the provision of digital skills training for specific purposes or labour market sectors (including a few cases where advanced and specialised digital skills training, e.g. ICT specialisms, AI, was the focus); and initiatives which described a combination of general (frequently basic level) and specific digital skills training, with a few investments focused on the provision of basic digital skills.

About a quarter of these initiatives were broad in nature, i.e. they described the provision of digital skills training within an overall lifelong learning approach, and these broadly-targeted investments tended to offer a mixture of basic and more advanced or specific digital skills training, often mentioning digital inclusion among their aims. A further 10% of investments were specifically focused on digital inclusion of vulnerable or marginalised groups. Around one-third of the investments were targeted at the labour market, where two trends emerged – the first was a focus on reskilling and upskilling for workers in vulnerable or evolving occupational sectors, which was often combined within the same investment with upskilling and reskilling of jobseekers, and the second was upskilling and reskilling that that was forward-focused on emerging technologies, and digital combined with green skills. A further quarter or so of these investments were targeted at business (particularly SMEs) and industry, and all of these consisted of specific or advanced digital skills training. The remaining 10% of investments in digital skills training outside of formal education were targeted at government employees

and these were linked to either general public administration or public services reform or to reforms of specific sectors (e.g. the judiciary).

An interesting difference that was observed across these investments is in terms of the ultimate driver of the investment. In some cases, digital skills provision was linked to national strategies in specific aspects of digital skills, e.g. AI, cybersecurity; while in others, digital skills provision investments were driven by labour market demand; and in yet others, digital skills provision investments were driven by digital and social inclusion for vulnerable groups.

4.1.2.3 Digital skills provision in formal education

With respect to formal education settings, **reforms** which featured the topic of digital skills provision in formal education were identified in 18 MS (and covered a little over 24% of reforms topics). These were reasonably evenly divided across primary and secondary, VET, Higher Education, and reforms that cut across both formal and non-formal education settings.

With regards to primary and secondary school, we identified curricular reforms in nine MS; two of these also include pre-primary education. In a majority of cases these curricular reforms relating to digital skills provision are part of a broader investment in education and skills and/or governance reforms.

Reforms in the Higher Education sector, meanwhile, were to facilitate a range of actions, for example, increasing course places in ICT-related undergraduate and/or postgraduate studies; to adapt both course content and structure (e.g. length, delivery mode) in order to better match to both digital skills supply and demand; and reforms to enable collaboration and digital skills knowledge transfer across HEIs and/or between Higher Education and industry.

Reforms in the VET sector covered governance, structural and training content elements. Examples of reforms in this sector include integration of new VET courses into the national qualifications framework; to strengthen the labour market relevance of VET courses; and to establish or strengthen co-ordination structures across VET, Higher Education, and/or businesses.

Investments for the provision of digital skills in formal education featured in the RRF national plans of 17 MS, accounting for 16% of digital skills investments topics. A little over half of these investments were targeted at Higher Education, covering a range of actions (e.g. increase in course places, provision of advanced or emerging technology specialist undergraduate and/or postgraduate courses, scholarships, supports for educators and students in general digital skills). In about half of the investments in Higher Education, collaboration with industry and/or international actors was a prominent feature. Roughly one in three of these investments was targeted at primary and/or secondary education, and just two of these made explicit reference to curricular reforms (with one additional RRF national plan referencing curricular reform of pre-primary). Rather, the focus of investments at these levels was on the promotion of digital skills among learners. The remaining investments entailed modernising of VET systems and course offer, with an increased focus on (digital) skills for the labour market.

A comparison of the reforms and investments, particularly with respect to curricular reform at primary and post-primary levels, could suggest that the pace of curricular reform implementation is lagging behind implementation of digital skills provision initiatives at other levels of the formal education system.

4.1.2.4 Equity, inclusion and wellbeing

Reforms which featured equity, inclusion and wellbeing were identified in 10 MS (and accounted for 9.5% of reform topics). A common feature of these reforms was the enhancement of existing programmes to strengthen digital and social inclusion. Examples of such reforms include: labour market-related measures to tackle the gender gap in the ICT sector; comprehensive reform of VET and/or active labour market policies in order to strengthen services to individuals with low skills, in disadvantaged communities, in vulnerable employment sectors, and/or with disabilities; establishment of structures to include outreach and guidance to vulnerable groups; and reform to support regional inequalities in digitalisation and digital skills. A couple of these reforms included explicit reference to wellbeing (alongside digital skills provision to promote digital and social inclusion), and a couple were specifically targeted at the integration and skilling of migrant groups (including digital skilling).

About two-fifths of the **investments** in digital skills provision featuring equity, inclusion and wellbeing sit within a broader social and digital inclusion agenda. The focus of these investments was on the provision of

basic digital skills training to specific groups, variously referred to as 'disadvantaged', 'marginalised' or 'vulnerable'. Examples include investment in basic digital skills for marginalised groups which includes conversion of libraries into digital skills hubs; dedicated digital inclusion packages which typically combine the provision of devices or equipment with digital skills training; and a couple of instances of investments targeted at specific groups, e.g. older persons, prison detainees, vulnerable women.

The remaining three-fifths of investments are located within broader active labour market skilling activities and a majority of these combine provision of basic, advanced and/or sector-specific digital skills training. These investments contain a strong focus on individuals not in employment, education or training. A core aim of these investments is to enhance the employability of individuals through enhanced skills matching to labour market need. While some of the investments are embedded more broadly within upskilling and re-skilling initiatives (including explicit reference to digital skills), others are specifically targeted at digital skills required for specific labour market sectors.

4.1.2.5 ITE and CPD, digital skills

Reforms that featured this topic were identified in six MS (5% of all reforms topics), while **investments** featured in five MS (5% of all investments topics).

Regarding **reforms**, half of these were targeted at primary and secondary levels of the education system and refer to curricular reforms accompanied by digital skills and digital pedagogical skills training for educators. Of the remainder, half involved ITE and/or CPD reform, again to enhance both digital skills and digital pedagogical skills of teachers, while the other half made reference to digital skills development of educators within broader Higher Education and VET reform actions.

A majority of the **investments** featuring this topic were targeted at primary and secondary education and related to CPD (rather than ITE) for digital skills development, which tended to have two main purposes: (i) to support curricular reform (again, digital skills training tended to be accompanied by CPD in digital pedagogies), or (ii) to support investments in infrastructure and platforms, where the aim of the CPD was to foster the development of technical digital skills in order to use these tools effectively for teaching and learning (e.g. hybrid settings).

The remainder of the investments featuring this topic were targeted at Higher Education settings, where the focus was on CPD for the acquisition of digital skills to accompany broader digitalisation and/or innovation reforms in these settings. Digital skills development was again accompanied by digital pedagogical skills training in these instances, along with digital skills training for learners.

4.1.2.6 Monitoring, evaluation and assessment

Reforms featuring this topic were identified in seven MS (accounting for 6% of all reforms topics). The reforms covered a range of areas, including the establishment of quality standards and or monitoring arrangements in VET systems; enhancements to competence identification measures and skills mismatch monitoring; and digital skills assessment in recruitment procedures.

Investments featuring this topic (in six MS and covering 6% of all investments topics), meanwhile, supported developments or enhancements in labour force digital skills assessment and monitoring; digital skills accreditation; and references to evaluations of proposed digital skills initiatives.

4.1.2.7 Opportunity and innovation

Too few **reforms** featuring this topic were identified to merit separate description/reporting.

Investments featuring opportunity and innovation were identified in nine MS, covering 9% of all digital skills investment topics. It can be noted that this topic tended to feature among MS with strong existing digital education and skills ecosystems.

The investments comprise, firstly, digital innovation projects that include an explicit mention of digital skills provision. Around half of these are broad programmes with actions that cut across non-formal education and industry; the remainder are focused mainly on either labour market or VET and Higher Education settings. A strong theme in these investments is the establishment or strengthening of public-private and/or multi-stakeholder partnerships/collaborations at regional, national, and/or international levels.

The remainder of investments featuring this topic were divided between broad initiatives to support emerging technologies which included an explicit focus on skills development (for example, AI, quantum computing); and initiatives that are targeted toward the development of specialised or more sector-specific digital skills development (such as biotechnologies and microelectronics).

4.1.2.8 Research and data

Too few **reforms** featuring this topic were identified for separate description/reporting. **Investments** relating to research and data on digital skills provision featured in the RRF national reports of seven MS (accounting for just 5% of all investments topics), and these MS also tended to be among those with robust digital education and skills ecosystems. These were focused on (i) enhancing research activities on advanced or specialised digital skills development, with an emphasis on collaboration and partnerships between Higher Education and industry and the internationalisation of the RDI sector, and (ii) research activities embedded within initiatives for the advancement of the application and development of skills relating to emerging digital technologies, such as AI and quantum computing. Links with the international research community were also a common feature of these investments.

4.1.3 Summary of findings from the RRF analysis

The RRF national plans provide high-level descriptions of major reforms and investments. This section considered only those components of the RRF national plans as they relate to digital skills provision. There is much variation in MS regarding the number of sub-components specified in their RRF national plans. This limits the interpretation to a broad qualitative overview of key themes, trends and gaps.

Just over half of the RRF national plan reforms that were classified within the **broad legislative and governance** reform topic (in 19 MS) consisted of broad skills-related reform or strategy development, while a further one-third or so consisted of legislative reforms covering a variety of themes (e.g. labour market flexibility/transition, VET modernisation; Higher Education rationalisation or modernisation, provision and monitoring of CPD).

Digital skills provision outside formal education was the topic with the highest frequency of investments (across 21 MS) and was accompanied by a sizeable number of reforms (across 19 MS). A majority of reforms under this topic (three-quarters or so) were variously targeted at the labour market generally; businesses and in particular SMEs; government; or citizens more generally. The remaining quarter or so consisted of descriptions of the development or implementation of broad, national plans or strategies, such as national digital skills plans. About a quarter of the investments which featured this topic were broad in nature, describing provision of digital skills training within an overall lifelong learning approach, and they tended to offer a mixture of basic and more advanced or specific digital skills training, often mentioning digital inclusion among their aims. About one in 10 were focused on digital inclusion. Around one-third of the investments were targeted at the labour market, where two trends emerged – a focus on reskilling and upskilling for workers in vulnerable or evolving occupational sectors, and forward-focused skills provision on emerging technologies, and green and digital skills combined. A further quarter were targeted at business (particularly SMEs) and industry, and all consisted of specific or advanced digital skills training. The remaining 10% of investments in digital skills training outside of formal education were targeted at government employees. Investments appear to vary in terms of their drivers, be they content (e.g. AI, cybersecurity, labour market demand) or digital and social inclusion priorities.

With respect to **digital skills provision in formal education settings**, reforms which featured the topic of digital skills provision in formal education were identified in 18 MS and were reasonably evenly divided across primary and secondary, VET, Higher Education, and reforms that cut across both formal and non-formal education settings. Curricular reforms at primary and secondary were identified in nine MS. Reforms in the Higher Education sector facilitated a range of actions (e.g. increasing course places adapting both course content and structure, and enabling collaboration and digital skills knowledge transfer across HEIs and/or between Higher Education and industry). Reforms in the VET sector covered governance, structural and training content elements. Investments for the provision of digital skills in formal education featured in the RRF national plans of 17 MS. A little over half of these investments were targeted at Higher Education, covering a range of actions. In about half of the investments in Higher Education, collaboration with industry and/or international actors was a prominent feature. Roughly one in three of these investments was targeted at primary and/or secondary education, and just two of these made explicit reference to curricular reforms.

Reforms which featured **equity, inclusion and wellbeing** were identified in 10 MS. A common feature was the enhancement of existing programmes, and a small number included explicit reference to wellbeing and the integration and skilling of migrant groups. About two-fifths of the investments in digital skills provision featuring equity, inclusion and wellbeing sit within a broader social and digital inclusion agenda. The focus of these investments was on the provision of basic digital skills training to specific groups. The remaining three-fifths of investments are located within broader active labour market skilling activities and a majority of these combine provision of basic, advanced and/or sector-specific digital skills training with a strong focus on individuals not in employment, education or training.

Reforms that featured **ITE and CPD for digital skills** were identified in six MS, while investments featured in five MS. Regarding reforms, half of these were targeted at primary and secondary levels of the education system and refer to digital skills and digital pedagogical skills training for educators as part of curricular reforms or reforms to ITE/CPD systems, while the other half made reference to digital skills development of educators in Higher Education and VET. A majority of the investments featuring this topic were targeted at primary and secondary education and related to CPD (rather than ITE) for digital skills development to support (i) curricular reform or (ii) investments in infrastructure and platforms. The remainder of the investments featuring this topic were targeted to Higher Education settings.

Reforms featuring **monitoring, evaluation and assessment** were identified in seven MS and concerned a range of themes including the establishment of quality standards and or monitoring arrangements in VET systems and enhancements to skills mismatch monitoring. Investments featuring this topic (in six MS), meanwhile, supported developments or enhancements in labour force digital skills assessment and monitoring; digital skills accreditation; and evaluations of proposed digital skills initiatives.

Too few reforms featuring **opportunity and innovation** were identified to merit separate description. Investments featuring opportunity and innovation were identified in nine MS, which tended to have strong existing digital education and skills ecosystems. Investments comprise firstly, digital innovation projects that include digital skills provision; second, the establishment or strengthening of public-private and/or multi-stakeholder partnerships/collaborations; third, initiatives to support emerging technologies; and fourth, the development of specialised or more sector-specific digital skills development.

Too few reforms featuring **research and data** were identified for separate reporting. Investments featured in the RRF national reports of seven MS and these MS again tended to be among those with robust digital education and skills ecosystems. These were focused on enhancing research activities on advanced or specialised digital skills.

Key observations from the analysis are that:

- As with the analysis of enabling factors for digital education, we did not see extensive reference to monitoring, evaluation or assessment activities in national RRF plan sections that refer to digital skills provision, although as noted in Section 3, it is the case that monitoring activities are referenced in the national digital skills strategies of some MS. Nonetheless, the monitoring of planned investments, particularly with respect to digital and social inclusion, may merit attention.
- With respect to digital skills assessment, there appears to be little emphasis on reforms or investments in this area either inside or outside of the formal education system. This is a gap which is explored further in the SD analysis in the next section.
- Third, with respect to digital skills provision in and outside of the formal education system, we observed that some MS are implementing broad reform programmes that cover both while others are tending to treat formal and non-formal education in a more separate manner. The links between the investments in digital skills provision inside and outside of formal education settings may merit further clarification and attention.
- Finally, a comparison of reforms and investments targeted at compulsory schooling suggests that the pace of curricular reform implementation is lagging behind implementation of digital skills provision initiatives at other levels of the system.

4.2 Provision of digital skills in the Structured Dialogue

4.2.1 Topic analysis overview

Through a combination of pre-defined and emerging topic analysis, seven topics were identified. Table 4.3 provides a description of topics.

Table 4.3. Descriptions of topics in the thematic analysis of structured dialogue meetings: digital skills provision

Topic	Description
Initiatives to boost digital skills outside of formal education settings	Digital skills training initiatives for upskilling and reskilling outside of formal education including, among others, digital skills training for jobseekers
Initiatives to boost digital skills in formal education settings, including curriculum reforms	Digital skills provision (e.g. courses and programmes) in primary/secondary, VET, and Higher Ed
ITE and CPD - digital skills*	Initial teacher education, continued professional development of teaching staff focused on more specific or advanced digital competence
Monitoring, evaluation and assessment, including existing or planned digital skills certification or accreditation schemes	Activities relating to the monitoring, evaluation or assessment of digital skills, including skills forecasting. References to assessment include existing or planned digital skills certification or accreditation schemes
Equity, inclusion and wellbeing	Digital skills initiatives targeted at specific groups including socio-economically disadvantaged, women, older persons
Research and data	Digital skills research and data activities, e.g. national research study
Opportunity or innovation	Innovative digital skills initiatives (e.g. in emerging technologies skills provision) or opportunities identified to build on existing digital skills provision

*Initiatives related to the enhancement of digital pedagogical skills of teachers/educators are included under enabling factors.

Note. Challenges, barriers and concerns in the development or implementation of an enabling ecosystem for digital education, where referenced, are classified under the specific topic(s) to which they refer.

Digital skills provision topics emerged under **two key groups**:

Direct-impact initiatives and actions (i.e. those with a direct relationship with the target group(s)):

- Digital skills initiatives outside of education settings (39%)
- Digital skills initiatives in education settings (including curricular reforms) (22% of digital skills provision topic instances)
- Equity, inclusion and wellbeing-related digital skills initiatives (10%).
- ITE and CPD for digital skills (6%).

Indirect-impact initiatives and actions (i.e. those with an indirect relationship with the goal(s) of the digital skills provision action(s)):

- Monitoring, evaluation and assessment (including digital skills certification or accreditation) (14%)
- Research and data (5%)
- Opportunity or innovation (5%).

On average across the 27 MS, 36 topic instances relating to digital skills provision were identified (range = 19-53) (Table 4.4). With the exceptions of research and data (21 MS), ITE and CPD for digital skills (21 MS), and opportunity and innovation (22 MS), all topics were referenced in the Structured Dialogue of all or almost all MS.

Overall, 16.5% of all topic instances referred to challenges or concerns. Topics in which challenges were most frequent are monitoring, evaluation and assessment (where 29% of topic instances were classified as challenges), and equity, inclusion and wellbeing (21%).

Also in relation to challenges, the topics most widely referenced across MS were again monitoring, evaluation and assessment (15 MS) and equity, inclusion and wellbeing (16 MS); as well as initiatives outside of education settings (23 MS) and initiatives in education settings (15 MS).

Table 4.4. Structured Dialogue frequencies of digital skills topics (N = 984) and challenges within topics (n = 162), together with the count of MS (N = 27) in which each topic and topic-related challenge is referenced

Enabling Factors Topic	*N topic instances*	*% of all topic instances*	*N challenges within topic*	*% challenges within topic*	*N MS in which topic is referenced*	*N MS in which topic challenge is referenced*
Initiatives to boost digital skills outside of education settings	382	38.8	53	13.9	27	23
Initiatives to boost digital skills in formal education settings, including curriculum reform	219	22.3	32	14.6	27	15
Monitoring, evaluation and assessment	137	13.9	40	29.2	27	15
Equity, inclusion and wellbeing	94	9.6	20	21.3	26	16
ITE and CPD - digital skills	58	5.9	10	17.2	21	8
Research and data	48	4.9	6	12.5	21	5
Opportunity or innovation	46	4.7	1	2.2	22	1
Total	984	100.0	162	16.5	N/A	N/A

A transversal theme, **EU support** (not displayed in Table 4.4), provides a description of suggestions from MS as to how these various challenges may be addressed at EU level. Roughly half of the 130 or so instances of EU support relate to digital skills (the other half relate to enabling factors).

As described in Section 2, each topic was classified within the analysis framework along several dimensions – target **group**, **level** (international, national, regional, mixed), and **sector** (education, employment, mixed; and public, private or mixed public/private) to provide insight into the location within the ecosystem of each topic instance.

The remainder of this section describes the key themes and challenges under each topic in turn. This is followed by a summary of references to EU support and a short summary of key findings.

4.2.2 Themes emerging from the Structured Dialogue analysis

4.2.2.1 Digital skills initiatives outside of education settings

Themes

This theme accounted for 39% of all digital skills provision topics, and featured in the structured dialogue meetings of all 27 MS. A majority of MS had been engaging in digital skills training initiatives outside of formal education settings over the past number of years. For general digital skills training, Public Employment Services (PES) and national Digital Skills and Jobs Coalitions were key vehicles for these training efforts, which were frequently embedded in active labour market policies and broader skills training initiatives.

An analysis of the content of commentary within this topic indicated six sub-areas of focus:

- initiatives that focused on the provision of **general** digital skills
- upskilling and reskilling initiatives with a **sector-specific** focus
- provision of **advanced** digital skills training
- initiatives with a **mixed** focus (e.g. the provision of both general and specific digital skills training offer within an integrated system)
- efforts to **co-ordinate and integrate** the provision of digital skills training outside of education settings

A recent emerging trend is that several MS have been or are in the process of implementing digital skills training initiatives at very large scale, using online solutions including MOOCs (massive open online courses) to maximise reach. Several MS were offering incentives such as free or subsidised training offers, and centralised digital skills training repositories, to encourage uptake. Digital reskilling and upskilling of staff in SMEs and the unemployed was of high priority for a large majority of MS, though these efforts were met with challenges, as described below.

However, for these large-scale initiatives the focus of the commentary was on delivering training to the desired group(s) rather than on monitoring the outcomes and impacts of these initiatives. Nonetheless, a small number of MS described recent and current technical initiatives which would enable the monitoring and tracking of digital skills training participation and outcomes (discussed further under monitoring, evaluation and assessment). In other words, while initiatives' aims and target groups were almost invariably described, and it was relatively common for targets to be referenced, there was less commentary on what measures are in place to ensure the quality and relevance of these initiatives or on the assessment of their impact.

There were some impressive and resource-intensive examples of comprehensive and targeted initiatives, for example, using local libraries or newly-established and local staff, including the creation of new digital skills co-ordinators, coupled with awareness-raising campaigns to reach and engage citizens at scale. In the Structured Dialogue, a majority of MS referenced their RRF plans and have committed to sizeable investments in digital skills training initiatives outside of formal education.

Within the context of digital skills training for the labour force, several MS were in the process of implementing digital skills training initiatives for civil servants as part of a broader reform programme for the civil service (or specific sectors of the civil service).

Challenges

About 14% of topic instances under this theme were classified as challenges, which is similar to the average rate of challenges across all topics (16.5%), and challenges related to this topic featured in 23 of the 27 structured dialogue meetings. Five areas of challenge in the provision of digital skills outside of formal education emerged from the analysis:

- In a majority of MS, the training offer was perceived to be currently insufficient to meet training needs for digital skills, both for the population and for ICT specialisms. Indeed, some MS reported challenges in the process of decision-making for effective and efficient investments in digital skills training, seeing a tension between a focus on high-level or advanced digital skills and digital skills for all.
- MS articulated the concerns and challenges that they were experiencing in terms of the ICT specialists shortage, citing evidence from both national and international sources. Estimates of the scale of ICT specialists shortages varied significantly across MS. MS identified various components to be tackled to meet this challenge. It was widely recognised that the economic attractiveness of the private ICT industry acted as a pull from other sectors, particularly those in the public and civil services (including the teaching profession). In this context, some MS referred to 'brain drain' where young ICT talent was leaving the country to work under more economically favourable conditions. However, it must be noted that several MS have established schemes to attract talent from abroad, including fast-track visa schemes and Higher Education study incentives, though it appears that it is too soon to gauge the success or impact of these schemes. It may be noted, though, that these visa and mobility incentive schemes operate differently across MS. Also, some MS reported successful outcomes via public-private partnerships to meet the growing need of ICT specialists through, for example, industry or private involvement in curriculum and course design, and strong links and/or agreements between education and enterprises at national, regional and local levels. Ultimately, it was clear from MS' perspectives

that meeting the ICT specialists shortages would require a concerted and multi-faceted efforts that cut across both formal and non-formal education settings.

- Some MS expressed difficulties in engaging their adult population in lifelong learning initiatives including those relating to digital skills and these MS were more likely to indicate a need for more investment in awareness-raising for adult education and training. They identified various groups at risk of social and economic exclusion, most frequently individuals in socioeconomically deprived communities, in geographically remote or rural communities, older individuals, and younger people with low levels of formal education. In addition, some MS suggested that a new group was emerging since the onset of the pandemic, and merited attention and support in digital skilling initiatives – older individuals of working age with some or mid-level formal educational qualifications. Depending on the economic profile of the MS, various labour market sectors were highlighted as being vulnerable and in need of digital upskilling and reskilling to adapt to the twin transition and increases in automation, for example, various sectors in tourism and manufacturing. The low representation of girls and women in the ICT sector was raised as a challenge and a concern, and all MS cited examples of initiatives to enhance female participation in the ICT sector. However, with few exceptions, these initiatives did not take a systemic perspective to identify and address the multiple causes of this challenge, with descriptions of initiatives tending to convey an incomplete and fragmented approach to gender equity.
- There was a perceived mismatch between digital skills training offer and training and labour market need. This was most commonly expressed in terms of concerns with supporting the acquisition of basic digital skills across the population, where it was widely accepted that engaging the most difficult to reach required meaningful and sustained effort at the local community level, by staff who understand the communities, their needs, and their local support services and infrastructures.
- Reflecting one of the priorities of the EC, as well as concerns in some MS, digital upskilling SME employees was viewed as a significant challenge. This concern was particularly acute in MS with relatively high proportions of their labour force employed in SMEs, coupled with lack of supports or incentives for SMEs employers to provide digital skills training to their employees.

4.2.2.2 Digital skills initiatives in education settings

Themes

Digital skills initiatives in education settings featured in all 27 structured dialogue meetings, with this topic accounting for 15% of all digital skills provision topic instances. There is considerable variation across MS in the positioning of digital skills in primary and secondary school curricula, including the extent to which curricular reforms were underway. Some emerging trends are described below.

In primary and secondary education:

- The understanding of the importance of the provision of digital skills in formal education has been articulated by all MS. MS vary in the way they refer to digital skills, with some putting more emphasis on ICT, others on digital competences, and others on informatics. Some MS focus more on digital literacy and safe use of the internet. European alignment on terminology would enable MS to gain a coherent understanding of digital skills and work towards a common direction.
- Some MS have already integrated digital skills into their curricula, and others are now designing their curricular reforms to ensure that digital skills are covered as part of the curriculum at both primary and secondary levels. A common element is that MS have realised the need to integrate digital aspects into their curricula responding to European priorities as set out in the Digital Education Action Plan 2021-2027. DigComp is widely used as a framework or tool from which to develop curricula, with some MS adapting the framework to national or regional context.
- MS which have recently or are currently implementing curricular reforms are tending to make digital skills a core subject at both primary and secondary levels; however, this is not invariably the case. Specific digital skills subjects aimed at fostering digital skills included into the curriculum (e.g. robotics, AI, coding) varies across MS, and some MS have developed a new subject that encompasses many aspects of digital skills, though again, the name and focus of this subject varies. There is considerable content, linguistic and cultural variation in what each MS is including in such subject, varying from basic ICT skills to robotics, coding, AI, digital literacy and media literacy.
- There is a low emphasis on the assessment of digital skills within curricular reform efforts. The current scenario is focused on ensuring that digital skills are put on the agenda in each MS, rather than at

assessing them. More effort may be needed in supporting MS ensuring an effective and efficient way of assessing digital skills and to align assessment with curricular learning outcomes. This observation is related to the monitoring, evaluation and assessment topic (discussed below).

- An emerging trend evident in some MS is the development of digital skills at preschool level, commonly using play-based approaches.

Within Higher Education initiatives:

- A substantial minority, about one-third, referred to programmes designed to teach general digital skills, while about two-thirds referred to initiatives designed to increase the provision of advanced or specialist digital skills (e.g. ICT specialists, AI, cybersecurity). In about half of MS, a combination of both approaches is being or will be implemented.
- To tackle ICT skills shortage, MS were implementing a variety of initiatives, frequently in combination, and often within broader STEM initiatives. These included the creation of additional ICT course places, creation of new courses, shorter or more flexible courses to adapt to the varying needs of learners, and/or subsidised courses (some via public-private partnerships). Attempts to attract more women into these courses, encouraging multidisciplinarity, and supporting the use of microcredentials were also recorded. Authorities in several MS expressed a need to find ways to increase the low demand for post-secondary ICT education, and to maintain graduate studies for specialised ICT skills, as well as meeting the current supply and 'industry pull' through shorter and flexible pathways. It was noted in several structured dialogue meetings that many ICT graduates are pulled into the market given the offers provided in the ICT market tend to be more attractive and do not always require that students finish their degree. In some countries, the ICT market is in competition for ICT teachers. Those with ICT speciality are more attracted to the ICT market than to teaching ICT given the job offers are more attractive, and this leads to a lack of ICT specialists that are dedicated to teaching.
- A secondary theme to boost digital skills of all was the introduction in some MS of more general digital skills courses into existing 'non-ICT' disciplines (humanities and social sciences), and training offers for Higher Education educators and students on digital skills. The general Higher Education initiatives tended to emphasise incentivising or otherwise increasing the levels of digital skills across a broad range of courses, or the incorporation of digital skills training in the more traditionally 'non-ICT' courses. Approaches underpinning the specialist initiatives vary, most commonly involving increases in relevant Higher Education courses, introduction of new Higher Education courses (at times in collaboration with industry), and/or introduction of flexible and/or short modules or conversion courses in ICT specialisms with integration of microcredentials in some cases.

We also found a small number of references to digitalisation efforts within formal education, efforts to co-ordinate the provision of digital skills within and across education settings, or between education settings and industry, and efforts to attract ICT talent into the country (e.g. with fast-track 'ICT visas' or measures to reverse 'brain drain' in the ICT sector).

Initiatives to boost digital skills were less commonly referenced in the VET sector. However, a strong emerging theme was efforts to align and reform VET curricula to labour market demand, with digital skills central to these alignment efforts and to accredit and integrate digital skills within the VET accreditation system. The development of VET teachers' digital competence remains an issue that still requires addressing in several MS. There was also a recognition of the particular positioning of VET within the education and training system and the complexities this brings – many MS authorities noted a need to elevate its status and to identify and address interdependencies with the other elements of the education system and labour market in policy implementation.

Within Adult Education, the dominant theme was the inclusion of digital skills, including reskilling and upskilling in broader initiatives. A common goal in this specific form of education is to avoid labour marginalisation due to digitalisation, while at the same time to encourage and support the transition.

Only a small number of digital skills provision initiatives within formal education were being implemented so as to foster stronger links between levels of the system, for example, VET and Higher Education; upper secondary and Higher Education.

Challenges

We identified four main challenges in the provision of digital skills in formal education. Challenges appeared in 15% of topic instances across 15 MS.

- Although some MS commented on the fact that the pandemic appears to have resulted in a shift in engagement of educators in CPD in digital skills, the sustainability of this effort is a challenge. Many MS cited low levels of interest/motivation/participation in digital skills CPD provision among education staff for a variety of reasons including ageing staff populations, existing overload and existing teaching staff shortages which put further pressure on the system. This challenge tended to be more pronounced in MS where digital skills were optionally in the curriculum and assessment systems. While a majority of MS indicated that digital skills were optional in educators' CPD, an emerging trend is to incentivise or make mandatory digital skills within CPD and, even more so, ITE.
- Many MS indicated challenges in assessing or monitoring digital skills levels of education staff.
- Particularly within primary and secondary education settings, MS described challenges in implementing digital skills and assessing learning targets within a transversal approach, where the responsibility for achieving learning targets is shared across teachers of different subjects. Also at primary and secondary level, legacy issues and the complexity of curricular reform were described, especially when moving from optional to mandatory subjects, and/or from a transversal to separate-subject or blended approach. For example, in moving from an optional to a mandatory subject, variations across schools in the implementation of the optional curriculum results in considerable differences between schools' capacity to implement a mandatory curriculum. In terms of the complexity of reform, many MS need to make difficult decisions in implementing the reform in a staggered manner across student cohorts over a number of years, while at the same time maintaining continuity in the learning experiences of students as they move through the system.
- As noted previously, there are quite widespread concerns about the numbers of ICT graduates and low retention rates in university courses, and recognition that overcoming this challenge requires a combination of actions, depending on the particular context of MS. In some MS, attractive job offers - from different sectors of the economy (e.g. tourism) - lead young people to drop out of their studies. The result of this situation is an increasing shortage of skilled ICT professionals and aggravation of job risk for workers (the unqualified or partially qualified are the most vulnerable to change).
- It was also noted that attracting more women into ICT courses and professions could be an important part of a solution to this challenge, while at the same time serving to bridge the ICT gender gap (a theme that is discussed further under equity, inclusion and wellbeing, below).

4.2.2.3 CPD and ITE, digital skills

Themes

This topic emerged in the structured dialogue meetings of 21 MS and accounts for just 6% of all digital skills topic instances. In and of itself, this could suggest the need to learn more about the initial and continuing professional development to foster digital skills of educators. Related to this, it is not clear in some cases whether the training offers of MS focused on digital pedagogical skills or specifically on the improvement of teachers' digital skills (or both).

A clear emerging trend regarding CPD on digital skills across MS is building on the experience of the pandemic. MS are extending the tools and supports in place to support teachers to build digital skills, making widespread use of online training, including MOOCs, and platforms that integrate digital skills and digital pedagogical training and solutions. These are described in more detail under Enabling Factors (Section 3). Some MS mentioned the willingness and enthusiasm of teachers and school leaders to participate in these CPD offers, having learned from the pandemic that digital skills offer benefits to both teachers and students. However, there were also concerns about the extent to which the engagement of teachers and school leaders in CPD would be sustainable. This said, the scale of training offer in CPD is impressive with commentary suggesting that this scaling up has been achieved in a relatively short time. The focus of the effort as emerging from the SD documentation is on raising participation rates (and some MS have recently introduced incentive schemes to encourage participation).

With respect to ITE, the general trend is towards the inclusion of digital skills as a core part in preparatory courses, but the manner in which this is assessed (or not) varies across MS, as already noted. Some MS require

digital skills training to start a teaching career, and it remains to be seen whether or not this requirement becomes more widespread.

The link between the digital skills acquired during ITE and how to sustain this with CPD was largely absent from SD discussions. Also, commentary on CPD and ITE for digital skills tended to occur in the absence of commentary on the actual or expected impact of such efforts, whether on teachers or students.

Challenges

Challenges relating to CPD and ITE for digital skills were identified in eight MS and in 17% of topic instances, which is similar to the average percentage of challenges (16.5%). The thematic analysis indicates that not many challenges were raised by MS in the area of CPD and ITE for educators in digital skills, over and above what has already been discussed under CPD and ITE in digital pedagogies in Section 3. As already noted, when these were mentioned, MS identified this as a general need and challenge and saw the current supports for teachers and educators in CPD in particular as insufficient. A small number of MS identified specific contextual challenges, including the optional nature of CPD resulting in a broad and fragmented training offer, a lack of incentives for teachers to participate in digital skills training as part of their professional development, the fact that teachers in need of participating in digital skills CPD tended to be more difficult to reach, and, inevitably, broader contexts such as existing shortages of teacher supply, age profile of teachers, and relative earnings of teachers which tended to exacerbate this challenge.

At least on the basis of the SD information, it seems that ITE and CPD for digital skills is an area in need of more attention, in terms of assessing and meeting need, monitoring implementation, and assessing impact.

4.2.2.4 Equity, inclusion and wellbeing in digital skills provision

Themes

This topic emerged in almost all (26 of 27) structured dialogue meetings and accounts for about 10% of all digital skills topic instances. The two dominant themes under equality, equity and wellbeing in the provision of digital skills referred to women and digital inclusion more generally.

Regarding women, a range of digital skills-related initiatives were mentioned by MS, some of these in place over a number of years. Most MS cited multiple initiatives aimed at gender equity which cut across both the education and employment sectors. These were quite varied, ranging from comprehensive multi-year programmes targeted toward girls and women in disadvantaged communities; industry-led mentoring programmes; information days and awareness-raising; educational projects designed to engage girls in technology; and digital upskilling and reskilling initiatives for women. With few exceptions, the descriptions of these programmes were not accompanied by information on their impact, and the use of comprehensive and systemic programmes for girls and women in ICT were uncommon. Nonetheless, the measures mainly concern efforts to educate women and tackle gender stereotyping and therefore seem to be aimed at longer-term change rather than short-term actions (such as temporary financial incentives).

Regarding digital inclusion, common initiatives included:

- Targeted digital skilling, reskilling and upskilling initiatives for jobseekers, most frequently under the auspices of Public Employment Services (PES), though at times initiatives were implemented with industry or other private partners.
- Targeted digital reskilling and upskilling initiatives for employers and employees of vulnerable labour market sectors (which varied across MS), sometimes in public-private partnerships.
- Courses on digital skills for elderly populations, including cybersecurity, frequently accompanied by outreach and engagement efforts.
- Digital skills trainings for migrant and refugee groups, often referenced within a broader initiative aimed at the inclusion and integration of these newcomers.
- Reskilling and upskilling initiatives implemented in rural and remote communities, commonly as a part of promoting employment opportunities in these areas.

Less commonplace but nonetheless a priority in some MS were initiatives to promote digital wellbeing and digital safety.

It was not commonplace for MS to specifically refer to individuals with special educational needs or disabilities; in contrast, some MS with specific ethnic or cultural minorities were implementing initiatives to support the digital skills development of these groups.

The phrase or concept of hard-to-reach groups appeared quite frequently in the structured dialogue meetings in the context of this topic, and it may be helpful to distinguish between two senses of this phrase, the first being hard to reach socially, (i.e. not socialising or integrated in their local communities, therefore requiring effort and locally-based outreach), and the second being geographically hard to reach. Many groups may be hard to reach in both senses.

Finally, while targets (in terms of participation or reach) were occasionally mentioned in the dialogues, commentary on impact is absent.

Challenges

Challenges in relation to equity, inclusion and wellbeing were identified in the structured dialogue meetings of 16 MS, and account for 21% of topic instances, which is somewhat higher than the average percentage of challenges across all digital skills topics (16.5%).

About half of the commentary on challenges relating to equity and equality concerned the under-representation of girls and women in ICT, most frequently expressed as a concern about the low share of females in ICT professions and ICT graduates (with some noting that the share of women in ICT professions is lower than the share of women ICT graduates). A small number of MS expressed a need to understand the causes of the gender gap better in order to address it.

The other challenges identified referred to digital inclusion and the digital skills gap more broadly, and tended to be expressed as a stated need to identify solutions and supports that could reach groups in vulnerable and remote communities. Frequently, this was expressed in conjunction with concerns about infrastructure, particularly connectivity. Equity, inclusion and wellbeing concerns are also discussed under Enabling Factors.

A factor common across all efforts to promote equity, inclusion and wellbeing in digital skills provision was the level of human resources required to engage meaningfully with individuals in the target groups, which in turn required an understanding of local community contexts.

4.2.2.5 Digital skills monitoring, evaluation and assessment

The topic of digital skills, monitoring and assessment appeared in all 27 dialogues and accounted for 14% of topic instances. It is an aspect of digital skills provision that was regarded as by MS as particularly challenging by MS: 29% of topic instances, mentioned across 15 MS, were classified as challenges, which is almost twice the percentage of challenges across all digital skills topics (16.5%). While there is widespread recognition and acceptance about the importance of monitoring, evaluation and assessment, additional support would be required to enable their implementation. Indeed, many MS are seeking EU-level support in this area, as is described later.

Themes

Monitoring, evaluation and assessment activities can be grouped as falling inside or outside of the formal education system.

In the formal education system, commonly-cited monitoring, evaluation and assessment initiatives suggest the following emerging trends:

- In about one-third of MS, digital skills certification is being implemented or is under development, with partial or complete alignment with DigComp being the most common approach. The target group(s) vary, and include students (at end of secondary school and in Higher Education), and multiple groups or the population. Again, the task of developing and implementing digital skills certification is widely viewed as complex and challenging.
- Some MS are moving towards or have already implemented digital skills certification of teachers as part of CPD, and some are in the process of developing monitoring systems for CPD for digital skills (e.g. to establish links across CPD providers in order to systematically track participation).

- A majority of MS include digital skills components in ITE, though these components are not always core or mandatory.
- Several MS are developing or implementing microcredentials and individual learning accounts in Higher and Vocational Education contexts, though this is widely seen as complex and challenging.
- Assessment of students' digital skills across MS shows a highly varied picture. For instance, some MS have added digital skills to their national examination systems (some transversally, others as a separate subject), while the national assessment of digital skills as part of a broader monitoring system is not widespread. However, there has been a growth in participation of international large-scale assessments, notably the International Computer and Information Literacy Study (ICILS). That said, just seven MS participated in ICILS in 2018, and 22[504] are indicated to take part in 2023. The next cycle of ICILS is in 2027, with the results of that cycle available at the end of 2028. More frequent measurement and monitoring of students' digital skills may be helpful in monitoring progress towards the 2030 targets.

Key themes emerging from non-formal education and training were:

- A majority of MS use multiple data sources, most commonly PES coupled with other data sources, to produce short, medium and long-term labour market forecasting, with most covering both supply and demand. Many MS have national digital competence observatories or systems whose information is used to enable data-informed policy responses, for example, more targeted training programmes.
- Some MS have recently implemented, or are implementing, systems to track digital skills training offers, but the monitoring of quality of training offer tends not a focus of these efforts.
- A minority of MS have established a comprehensive system of assessing and monitoring digital skills.

Challenges

As already noted, a majority of MS were experiencing challenges in the monitoring, evaluation and assessment of digital skills provision.

- The key challenges in Section 3 under monitoring, evaluation and assessment; and engagement and partnerships, particularly in relation to whole-of-government approaches to policy implementation, can be seen also to apply to digital skills provision.

Other common challenges are summarised below.

- Several MS described challenges in scaling up initiatives and expressed a desire to gain knowledge and capacity to identify and quickly scale up promising or successful small-scale or pilot digital skills initiatives
- There was a perceived need to develop both microcredentials (i.e. recognition of short courses or training) and digital skills certification to support the monitoring of individual learning pathways and agility in responding to the challenges of the digital (and green) transition). While some MS indicated that these were already in development, others expressed a need for technical support and raised the issue of cross-institution, cross-sector and cross-country interoperability and quality assurance of both microcredentials and digital skills certifications, as well as for a common approach to the definition and measurement of digital skills.
- Some MS indicated that the assessment and monitoring of teachers' digital skills were a challenge; this tended to be more frequently a challenge where CPD was optional and training offers were spread across a range of education and training providers. Aside from digital skills of educators, some MS also cited a lack of digital skills assessment tools (as opposed to digital skills self-reflection tools) in formal education and the population more broadly as a barrier to the effective monitoring of digital skills policies. There were higher levels of success with these efforts in MS where DigComp or other competence frameworks were being implemented in a comprehensive manner across digital skills curricula, assessment, education and training initiatives.
- While a majority of MS have skills forecasting activities in place, two challenges in this area were commonly referenced: first, national data and capacity to produce longer-term digital skills forecasts; and second, challenges in resolving the tension between sectoral skills forecasting and the more

[504] One of the 22 MS participating in 2023, Belgium, covers only the Flemish Community. See https://www.iea.nl/index.php/studies/iea/icils/2018 and https://www.iea.nl/index.php/studies/iea/icils/2023.

transversal perspective that digital skills forecasting (particularly for maintaining an up-to-date and agile training offer) requires.

- From a conceptual point of view, several MS commented that that impact assessment (in the sense of the measurement of impact of measures designed to support the acquisition of digital skills) is generally extremely challenging, and several MS expressed a desire to build capacity in this area and learn from other MS.
- Other challenges under monitoring, evaluation and assessment related specifically to individual MS, where national authorities identified gaps in digital skills policies and provision that needed to be addressed. These included, for example, digitalisation policy in Higher Education, an industrial digital skills policy, and more engagement with social partners and industry in monitoring, evaluation and assessment efforts.

4.2.2.6 Research and data

Themes

Research and data on digital skills featured in the structured dialogue meetings of 21 MS and accounted for just 5% of all digital skills topics. The bulk of MS' research efforts and data focus were on digital skills in the employment sector. A range of research methodologies were being employed by MS to provide data for policy on digital skills provision (e.g. big data analysis, surveys, interrogation of Public Employment Services data; thematic research reports by national research agencies), and while some research studies focused on specialist or sectoral digital skills, others examined broader, transversal digital skills; a common theme among all is an attempt to better identify labour market digital skills need, gaps and trends.

A second emerging trend in research and data on digital skills provision relates to research on emerging technologies (AI and quantum computing), often embedded within a broader programme of innovation.

A third emerging theme relates to the establishment of digital skills data hubs or data warehouses, to permit improved monitoring of various aspects of the digital skills ecosystem, such as training offer, graduate tracking, and labour market trends.

Fourth, there were a small number of references to specific research studies on digital skills provision including evaluations of digital skills curriculum reforms, the acquisition of digital skills in students, and ICT course drop-out causes and prevention.

Challenges

The key challenge under research and data to support digital skills provision related to labour market and employers' needs. This was expressed in two senses; first, in terms of the lack of available data in this area and the resulting difficulty in meeting labour market demand with supply by digital skills reskilling and upskilling; and second, in terms of challenges relating to obtaining digital skills demand data in a timely and efficient manner, for example, by engaging employers effectively.

4.2.2.7 Opportunity and Innovation

The nature of this topic, which emerged in the structured dialogue meetings of 22 MS and covering 5% of digital skills topics, is twofold. On the one hand, it describes the actions and lessons of MS in response to the pandemic which were used as a foundation to build on for digital skills provision; on the other, it describes initiatives among MS to boost digital skills in innovative ways and/or boost digital skills relating to emerging and advanced technologies such as AI and quantum computing.

Themes

The pandemic has tested all countries' education and training systems in ways that could not have been foreseen.

A majority of MS are using and building on the lessons of the pandemic as an opportunity to:

- Enhance and up-scale the digital skills training offer, building on developments in response to the pandemic, across both education and employment sectors.

- Build on the newly-established lines of communication and collaboration across government, levels of the system, with social and industry partners, to continue the digital transformation in targeted ways (e.g. strengthened industry and employer involvement in VET; continued public-private partnerships for digital skills initiatives).
- Harness the recent changes to accelerate the transformation of education systems, particularly in the Higher Education sector.

Regarding innovation:

- Digital Innovation Hubs (i.e. support facilities for businesses to become more competitive by improving their business/production processes as well as products and services by means of digital technology) have been established in a majority of MS, though most are not yet sufficiently well-established yet to demonstrate impact.
- Some MS are implementing initiatives to promote AI skills both inside and outside of formal education.
- Some MS have created new partnerships (government-academia; public-private; Higher Education and industry, for example) to support skills development in emerging technologies, most commonly AI.
- A small number of MS mentioned extensive, large-scale projects or initiatives, some of these involving multiple MS, on emerging or advanced technologies, which include a digital skills component.

Challenges

Aside from the significant difficulties and challenges that had emerged with the onset of the pandemic, MS did not raise significant challenges relating to opportunity or innovation.

4.2.2.8 EU support for digital skills provision

Suggestions for support at the EU level were provided by 21 MS. These are summarised below.

- MS sought for further opportunity to exchange with one another on good or best practices, or solutions to issues of shared concern; these covered:
  - engaging with hard-to-reach groups for digital skills provision;
  - fostering a culture of data-driven policy-making;
  - increasing the share of women in ICT professions;
  - successful strategies for responding to digital skills needs in rapidly evolving contexts;
  - good practices in governance and co-ordination of digital skills policies; and
  - development of public-private partnerships for digital skills provision.
- MS also sought further opportunities for exchange with the EC and/or efforts on the part of the EC to support the co-ordination of activities of MS in a range of areas. These included:
  - the co-ordination of efforts to address digital skills gaps;
  - multi-country projects on digital skills provision, for example, Digital Innovation Hubs;
  - the evaluation of digital skills provision initiatives;
  - clarity in the relationships between the various EU-level digital skills bodies, initiatives, strategies and funding instruments;
  - technical and operational support for the adoption/integration and monitoring of digital skills through microcredentials;
  - support for awareness-raising for digital skills particularly among employer groups;
  - support for the implementation of impact assessment; and
  - tackling the gender divide in ICT.
- To support their efforts, MS also requested support at EU level in relation to digital assessment (as opposed to self-reflection) tools for general and specific populations; tools for the monitoring and evaluation of digital skills policies and initiatives; and suggestions for further development of digital skills frameworks, such as the development of a digital skills/digital competence framework for civil servants.
- MS called for further research and analysis in two areas specifically: forecasting of digital skills, and digital skills provision mapping across formal and non-formal education and training systems.

4.2.3 Summary of findings from the Structured Dialogue

Two groups of digital skills provision topics emerged from the analysis of SD documentation. These are **direct-impact** initiatives and actions (digital skills initiatives in education settings; digital skills initiatives outside of

education settings; ITE and CPD for digital competence/skills; and equity, inclusion and wellbeing-related digital skills initiatives); and **indirect-impact** initiatives and actions (monitoring, evaluation and assessment; research and data; and opportunity or innovation).

The SD discussions highlighted challenges relating to initiatives both inside and outside of formal education settings; equity, inclusion and wellbeing; and monitoring, evaluation and assessment.

Digital skills initiatives outside of education settings was the most frequently referenced topic in the SD discussions; this is consistent with what was observed in the RRF national plan analysis. It was possible to distinguish between four kinds of initiatives: skills provision that was general, sector-specific, advanced, or mixed; along with efforts to co-ordinate and integrate these four kinds of digital skills provision. The focus of the commentary was on delivering training to the desired group(s) rather than on monitoring the outcomes and impacts of these initiatives, though monitoring of this kind was in place in a minority of MS. Also consistent with what we saw in the RRF national reports, several MS are in the process of implementing digital skills training initiatives for civil servants.

In a majority of MS, the training offer was perceived to be insufficient to meet current need, both for general training and for ICT specialisms, with a tension expressed between investing in high-level or advanced digital skills and digital skills for all. A majority of MS expressed concerns about the ICT specialists shortage and provided both analysis and solutions for the issue. From this, it is clear that meeting this shortage would require a sustained and multi-faceted effort. Some MS reported that engaging adults in digital skills training was challenging and underlined the need for more awareness-raising in this regard, as well as the need to invest effort and human resources in outreach efforts at the local community level. MS also discussed and highlighted specific labour market sectors that were seen to be particularly in need of upskilling and reskilling, which varied depending on their specific national economic contexts. Upskilling and reskilling of SME employees was seen to be more of a challenge in MS where large percentages of the workforce were employed in SMEs. There were also several descriptions of initiatives to enhance female participation in the ICT sector; however, these initiatives tended to convey a fragmented approach.

Regarding **digital skills provision in formal education**, recent and current curricular reforms were referenced by about two-thirds of MS. There is considerable variation across MS in the positioning of digital skills in national curricula for example with respect to the inclusion of specific skills and subjects (e.g. programming, robotics, AI). However, the importance of the provision of digital skills in formal education is recognised across all MS. Within these varied contexts, there is a low emphasis on the assessment of learners' digital skills, which indicates that further efforts in assessing digital skills and to align assessment with curricular learning outcomes need to be made.

Despite this wide variation, there is an emergence of some early trends across MS. There is an emergence of teaching digital competence both transversally and as a separate subject. In upper secondary, tertiary and VET, additional digital skills subject(s) are available in several MS, commonly on an optional basis. There is also an emergence of teaching and learning informatics at upper primary and lower secondary levels, commonly as a separate, core subject.

In Higher Education, there is more of a focus on the development of programmes to teach specialist and advanced digital skills than on general digital skills; this is consistent with what was observed in RRF national plans. About half of MS reported implementing a combined (generalist-specialist) approach in Higher Education. Also, to tackle the ICT skills shortage, MS are implementing a variety of initiatives including more course places, and shorter or more flexible courses, many supported by microcredentials development. Many MS sought solutions to the labour market pull of ICT students and identified competition between these courses and those for ICT teachers. Some MS mentioned the development or implementation ICT profession visa schemes and/or schemes to attract students from overseas to enrol in ICT courses to tackle this shortage.

Although less frequently referenced, a strong emerging theme in the VET sector is a focus on aligning and reforming VET curricula to labour market demand, with digital skills playing a major role in these efforts. From the SD discussions, it seems that teachers' digital competence requires more attention within the broader context of elevating the status of VET more generally.

Three key challenges were identified in digital skills provision in formal education:

- Challenges in achieving sustained engagement of teachers and educators in CPD, which is exacerbated by teacher shortages in several MS: some highlighted a need to incentivise or make CPD mandatory.
- Particularly within primary and secondary education, MS reported challenges in implementing and assessing learning targets in a transversal approach. More generally, curricular reform was viewed a challenging, for a variety of reasons.
- The widespread concerns about the number of ICT graduates was viewed in some of the SD meetings (expressed in terms of ICT course demand, number of ICT course places, and ICT course graduation rates) as an opportunity to bring more women into the profession.

In some SD meetings, MS representatives suggested that further alignment of digital education terminology at the European level would support MS to work together in a common direction in this regard, across both formal and non-formal education settings. Some suggested that DigComp could provide a basis for terminology alignment.

A clear trend in the provision **of CPD and ITE in digital skills** is the widespread use of online training at scale, building on the experiences of the pandemic. The general trend in ITE is towards the inclusion of digital skills as a core part of preparatory courses, but assessment of digital skills in ITE varies across MS. The link between the digital skills acquired during ITE and how to sustain this with CPD was absent from SD discussions, and the discussions did not provide much information on the expected impacts of teacher professional development. In MS where CPD was optional, there were more challenges in engaging the teaching profession, and the training offer tended to be more broad and fragmented.

Regarding **equity and inclusion** in digital skills provision, one of the two dominant themes was women in ICT. Various initiatives were described but these tended not to be accompanied by information on their impact, and systemic and comprehensive programmes were not at all widespread. The second theme was digital inclusion, which covered a range of targeted skilling, reskilling and upskilling initiatives (for unemployed, low-skilled, elderly populations, rural and remote communities, migrants and refugees). It was not commonplace for MS to refer specifically to individuals with disabilities or special educational needs. A key challenge in equitable provision of digital skills raised during the SD discussions is the level of human resources required to engage meaningfully with the target communities.

Monitoring and evaluation of digital skills provision was, consistent with what was found with respect to the SD on the enabling factors topics, viewed as generally challenging. Several trends in this area emerged from the SD discussions: skills accreditation in VET; early use of microcredentials in Higher Education and VET; and interest in digital skills certification. Challenges in this area, in addition to those already identified in Section 3, related to scaling up successful initiatives; complexity in developing microcredentials and digital skills certifications; the measurement and monitoring of teachers' digital skills; accurate digital skills forecasting; and general complexities associated with impact assessment.

Research and data in relation to digital skills provision were concentrated in the employment sector, where a range of data sources and methodologies were being implemented for forecasting, to provide data on policy for digital skills provision. Several SD discussions included references to research and data on emerging technologies, and many MS had established or were establishing digital skills data hubs or warehouses. The key challenge in this area was the timely availability of appropriate data for skills forecasting.

Regarding **opportunity and innovation**, a large majority of SD discussions demonstrated significant learnings from the onset of the pandemic and efforts to continue to build on these. Also, many MS referenced digital innovation hubs, and several are implementing initiatives to promote AI skills or other emerging and advanced technologies, often through the creation of new partnerships.

Suggestions for **support at the EU level** were provided by 21 MS. A majority sought further opportunity to exchange learning and good practices in a range of areas, including engaging with hard-to-reach groups, increasing the share of women in ICT; developing data-driven policies; responding to rapidly-evolving skills needs; and development of public-private partnerships.

MS also sought further opportunities for exchange with the EC and/or efforts on the part of the EC to support the co-ordination of activities of MS in a range of areas. These included the co-ordination of efforts to address digital skills gaps; support for multi-country projects on digital skills provision; evaluation of digitalisation and

digital skills provision initiatives; clarity in the relationships between the various EU-level digital skills bodies, initiatives, and funding instruments; technical and operational support for the adoption and monitoring of digital skills microcredentials; support for awareness-raising on digital skills, in particular among employer groups; support for the implementation of impact assessment; and strategies to tackle the gender divide in ICT,

To support their efforts, MS also requested support at the EU level relating to digital assessment tools for general and specific populations that would be underpinned by a measurement model; tools for the monitoring and evaluation of digital skills provision; and provided suggestions for further development of digital skills frameworks. MS also called for further research and analysis in two areas specifically: forecasting of digital skills, and digital skills provision mapping across formal and non-formal education and training systems.

4.3 Submissions to the Call for Evidence on digital skills provision

This section considers the themes emerging from the submissions to the Call for Evidence on digital skills provision. An overview of topics is first provided. This is followed by a description of the main themes emerging; finally, we provide a summary of key findings.

4.3.1 Topic analysis overview

Table 4.5 provides a description of each of the nine topics that emerged from the submissions to the Call for Evidence, while Figure 4.2 shows the frequencies of topics across submissions.

The content of the submissions is quite widely distributed across topics, with slightly higher coverage (12-22.5%) of:

- Digital skills provision in formal education (22.5%)
- Digital skills initiatives outside formal education (15%)
- Equity, inclusion and wellbeing (13%)
- Digital skills gaps (12%).

There is a moderate level of coverage (6-9%) of:

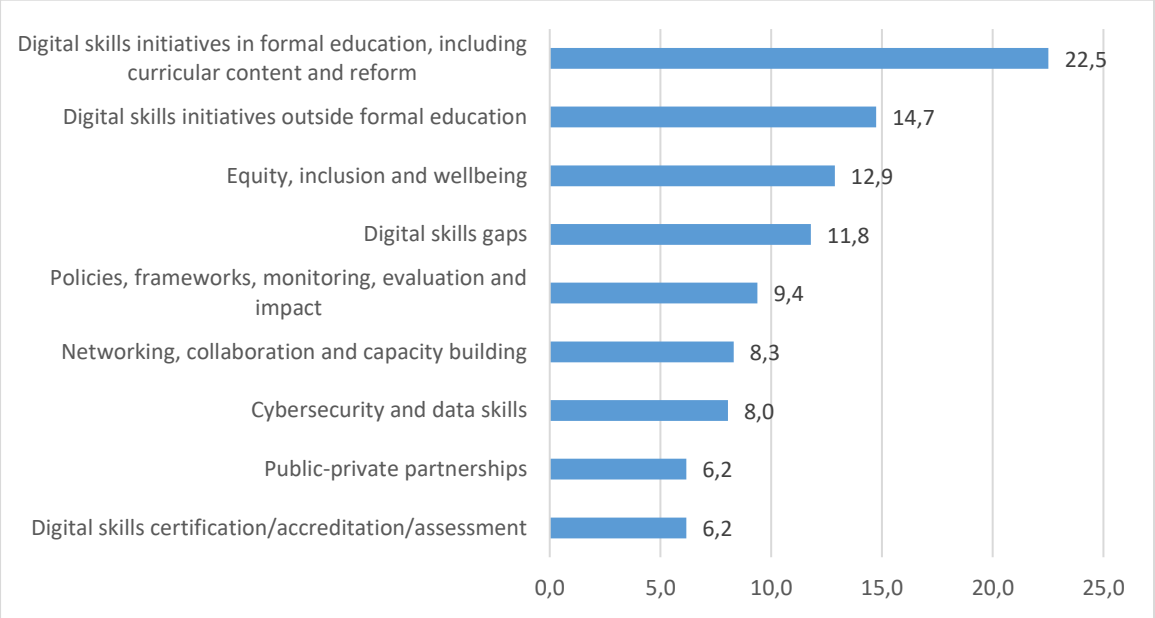
- Policies, frameworks, monitoring, evaluation and impact (9%)
- Networking, collaboration and capacity building (8%)
- Cybersecurity and data skills (8%)
- Public-private partnerships (6%)
- Digital skills certification/accreditation/assessment (6%).

Table 4.5. Description of topics emerging from the analysis of the Call for Evidence on digital skills provision

Topic	Description
Digital skills provision in formal education, including curricular content and reform	View and perspectives on digital skills provision in formal education settings (primary, secondary, VET and Higher Education), including perspectives on curricular content and reform
Digital skills initiatives outside formal education	View and perspectives on digital skills provision outside of formal education settings, for example for employees or jobseekers
Equity, inclusion and wellbeing	Views emphasising the importance of social and digital inclusion, and digital wellbeing
Digital skills gaps	Comments on challenges to and solutions for digital skills gaps
Policies, frameworks, monitoring, evaluation and impact	Comments on approaches to digital skills policymaking and/or use of frameworks in digital skills policy implementation; views on the role of monitoring, evaluation and impact assessment in the digital skills provision ecosystem

Networking, collaboration and capacity building	Views emphasising the importance of collaborative activities in digital skills provision, including across individuals, institutions, sectors, Government departments and MS
Cybersecurity and data skills	Views emphasising the importance of cybersecurity skills and data literacy and related themes including online safety, protection of personal data, cybercrime and cyberbullying
Public-private partnerships	Comments public-private collaborations and partnerships in relation to digital skills provision
Digital skills certification/accreditation/assessment	Views and perspectives on digital skills certification, accreditation and assessment, including microcredentials

Figure 4.2. Frequencies of topics emerging in the submissions to the Call for Evidence on digital skills provision



Stakeholder groups varied with respect to the relative emphasis given to the various topics. This is shown in Table 4.6, using 'heat' coding to illustrate topics with higher (orange to red) and lower (yellow to green) levels of emphasis across stakeholder groups.

Table 4.6. Distribution of enabling factors topics in the submissions to the Call for Evidence on digital skills provision by stakeholder group

Topic	*Academic/ research Institution*	*Business association*	*Business/ Company*	*Individual*	*Non-profit or non-government organisation*	*Professional association*	*Public Authority*	*Trade union*	*Other*	**Total**
Digital skills provision in formal education, including curricular content and reform	47.4	32.4	28.3	26.7	15.4	0.0	21.4	33.3	18.3	**22.5**
Digital skills provision outside formal education	0.0	21.6	10.9	23.3	14.0	14.3	7.1	33.3	16.7	**14.7**
Equity, inclusion and wellbeing	0.0	5.4	4.3	20.0	21.3	0.0	17.9	0.0	6.7	**12.9**
Digital skills gaps	5.3	10.8	8.7	6.7	11.0	42.9	7.1	0.0	21.7	**11.8**
Policies, frameworks, monitoring, evaluation and impact	15.8	2.7	13.0	0.0	13.2	0.0	7.1	0.0	8.3	**9.4**
Networking, collaboration and capacity building	21.1	8.1	6.5	3.3	5.1	0.0	21.4	22.2	8.3	**8.3**
Cybersecurity and data skills	5.3	2.7	0.0	10.0	11.0	14.3	7.1	0.0	11.7	**8.0**
Public-private partnerships	5.3	13.5	6.5	6.7	3.7	14.3	7.1	0.0	6.7	**6.2**
Digital skills certification/accreditation/ assessment	0.0	2.7	21.7	3.3	5.1	14.3	3.6	11.1	1.7	**6.2**
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	**100.0**

The table shows differences in the relative contributions of stakeholders which vary depending on their role or perspective. For example:

- Digital skills provision in formal education (including curricular reform) were given a relatively high emphasis by academic/research institutions, while provision outside of formal education and training was a major focus of Trade Unions.
- Equity, inclusion and wellbeing were emphasised to a relatively high degree in submissions from non-profit and non-government organisations, and from individuals.
- Academic/research institutions, Trade Unions and public authorities placed a relatively high emphasis on networking, collaboration and capacity building
- Public-private partnerships arose as a topic more frequently than on average in submissions from business and professional associations
- Digital skills gaps were particularly emphasised more by professional associations
- Digital skills certification, accreditation and assessment were referenced more frequently by businesses/companies, professional associations, and Trade Unions.

4.3.2 Themes emerging from the Call for Evidence analysis

In this section, we discuss the themes emerging within each of the topics, in order of frequency (from most to least-frequently mentioned topic).

4.3.2.1 Digital skills provision in formal education settings

Generally, the submissions espoused a holistic and learner-centred approach to digital skills provision in formal education settings, noting that it should be balanced with other skills including metacognitive (learning to learn) and transversal skills learning, as well as age-appropriate and adapted to individuals' needs. It was also noted that autonomy should be a goal of digital skills provision in education systems.

The digital skills of teachers emerged as a concern where it was recognised that more teaching and training staff would be needed to support the provision of digital skills in education settings. The skills of teachers should, according to some submissions, be continuously updated, recognised and supported by peer learning and several of the submissions highlighted the importance of teacher skills in specific areas (e.g. AI, cloud technologies, data and data analytics).

Regarding curricular content and reform, we identified areas of both convergence and divergence.

- There was widespread recognition across the submissions that digital skills teaching and learning should be a core part of curricula from an early (lower primary) age. Some submissions highlighted the need to modernise primary and secondary curricula, and there were suggestions for increased collaboration between HEIs and industries to collaborate to support curricular reform.
- Second, there was recognition of the importance of teaching and learning of informatics from primary level (referred to also as computer science, programming and computational skills).
- Many of the submissions expressed the view that digital skills teaching and learning should occur alongside other core skills development, including problem-solving, critical thinking, creativity and wellbeing, i.e. that they should be embedded within a broader skills framework.
- A fourth common theme was that of harmonisation and alignment of curricula, across primary, secondary and VET, and also across EU MS
- Fifth, regarding Higher Education, there were calls to promote cutting-edge digital skills provision and research, as well as multi- and inter-disciplinarity.

There was diversity in perspectives expressed, with respect to whether or not:

- specialised courses such as computer science should be core or optional parts of the curricula
- digital skills across the range of proficiency from basic to advanced should be taught to all students
- formal education curricula should be aligned to the labour market.

4.3.2.2 Digital skills education and training outside of formal education

The five main themes that emerged under this topic were:

- A need to adapt digital skills training offer content to the needs to individuals, professions, sectors, and specific groups (particularly low-skilled), along with more modularity and flexibility in structure
- The importance of recognising digital skills training as an integral part of education and training systems, seen alongside critical thinking, problem-solving, and soft skills
- Calls for an increase in training offer and/or awareness-raising among enterprises and SMEs
- Calls to leverage existing EU funding and collaborations to support provision, increase the level of EU funding
- Suggestions to foster links and synergies between formal and non-formal education.

The remaining content under this topic provided specific suggestions for ways to boost digital skills, e.g. boot camps; and emphasised the health dimension of digital skills training.

4.3.2.3 Equity, inclusion and wellbeing

In articulating perspectives on equity, equality and inclusion, it is interesting to note that those submissions which did identify specific groups which they felt should be prioritised in terms of inclusive digital skills provision, most of these identified a single group, most commonly women, followed by disadvantaged/vulnerable groups, and individuals with disabilities; there were a small number of references to other groups (rural communities or older persons, for example).

Several of the submissions referred to multiple groups, indicating awareness and concern for the layered nature of social and digital inclusion/exclusion. The content of the submissions where specific groups were mentioned tended to underline the need for greater inclusion of the group in question in digital skills provision.

Regardless of the group prioritised, the commentary on equity, inclusion and wellbeing indicates three specific perspectives:

- The digital divide was seen as a social problem, where rights-based approaches needed to be more strongly incorporated into digital skills provision, including giving learners a voice.
- Information on best and successful practices in overcoming the digital divide should be collected and disseminated, for example, approaches that are successful in engaging hard-to-reach groups.

- The overall 80% target for 2030 should be disaggregated to specify disadvantaged and vulnerable groups to avoid further exacerbating the digital divide, and this should be supported by a specific programme including an evaluation of the programme's outcomes.

4.3.2.4 Digital skills gaps

The commentary on this topic was quite varied, perhaps reflecting a recognition of the complexity of this issue. Broadly speaking, the commentary on digital skills gaps can be categorised into specific and general.

Some of the commentary on digital skills gaps was quite general in nature, for example stating that a range of interventions is needed to address the digital skills gaps, that there is a need to boost digital skills in the workforce, or that both digital and soft skills should be fostered (in general).

Underpinning much of this commentary were the two complementary perspectives of holistic approaches and inclusive values. That is, digital skills form part of a broader set of skills, and that digital skills provision is for all citizens.

Another common theme was a perceived need to foster digital skills in emerging and advanced technologies, and in specialist areas (e.g. data specialisms, quantum computing). A second emerging theme was that ICT specialist skills can be taught and learned and as a result, recruitment practices should be broadened to 'hire-and-train'. It was also noted that there is potential in partnerships between education and industry to achieve this.

Submissions also noted that:

- Closing the gender gap in ICT professions would help with the ICT specialists shortage
- There is a shortage of ICT specialist teachers
- There is a need to upskill and reskill employees in specific sectors (e.g. healthcare, social care).

4.3.2.5 Policies, frameworks, monitoring, evaluation and impact

Some of the commentary under this theme consists of general observations regarding the importance of embedding monitoring into the digital skills policy cycle. For example, submissions noted that:

- Empirical evidence should guide policy
- There should be stronger links between research and education
- Monitoring and evaluation mechanisms are needed from the outset of policy or initiative development in order to ensure impact and sustainability of digital skills policies and initiatives, and this needs to be more widespread across MS
- There is a need for the development of more consistent metrics regarding digital skills provision in order to strengthen the monitoring of progress of MS in digital skills targets.

More specifically, the submissions noted that:

- Meeting the data needs for digital skills forecasting is challenging, but there is potential for collaboration between education and training providers and industry to address these needs
- There is a need for more disaggregated data to define and monitor digital skills targets (for example with respect to specific sub-groups of the population), which in turn could help to focus engagement on specific policy issues
- There is a need to measure and monitor the effectiveness of teacher training through assessment of their learning outcomes (digital skills levels)
- There is a need for reliable data on digital skills education and training offer
- EC frameworks relating to digital skills (DigComp, DigCompOrg and DigCompEdu) and associated tools (SELFIE and SELFIEforTEACHERS) as well as LifeComp are useful for the development and implementation of digital skills strategies, curriculum, education and training, and teacher and student development, and that awareness-raising about these frameworks and tools would be helpful

- There is a need for clarity and enhancements to definition and measurement of digital skills, for example, more precision in the definition of basic digital skills, the development of digital competence profiles that are sector- or occupation-specific, and a framework for a programme to support basic digital skills acquisition.

4.3.2.6 Networking, collaboration and capacity building

Under this topic, a strong unifying theme of strengthening co-operation and co-ordination emerged. Submissions emphasised the need for co-ordination across actors in a range of ways: across EU countries to promote sharing of good practices; between stakeholder groups within MS (particularly social partners); across government departments and between their various levels of governance; between education and labour market stakeholders; and in Higher Education, across disciplines. The overall goal of this of strengthening of co-operation and co-ordination, as some of the submissions stated, is to achieve a coherent and systematic approach to the provision of digital skills inside and outside of formal education settings.

The submissions also highlighted specific issues where further attention or effort was needed, for example, in tackling the shortage of ICT professionals, actions to promote digital inclusion, and digital skills provision for SMEs.

4.3.2.7 Cybersecurity and data skills

About 8% of submissions' content related to cybersecurity and data skills provision. About a quarter of this commentary referred to the importance of data literacy and data management skills generally and their embedding in overall digital skills development.

The remainder focused mainly on the importance of cybersecurity and data protection skills training, where the general view was that all citizens needed to be aware of and use these skills. A small number of the submissions suggested specific ways in which cybersecurity and data protection skills could be fostered, for example by embedding risk awareness, security needs and data usage awareness in all digital skills training; or via co-operation with the IT industry or social media platforms to deliver training in this area.

4.3.2.8 Public-private partnerships

In Section 3, it was noted that the CfE submissions relating to enabling factors expressed some ambivalence towards public-private partnerships. This was not the case in the CfE submissions on digital skills provision, where there was unanimous support expressed for public-private partnerships or collaborations in digital skills provision. Of course, how this was articulated showed some variation.

Some of the submissions focused their attention on the potential benefits of partnerships and collaborations between Higher Education and industry; others referred to the education sector and EdTech industry partners, while others still referred to tripartite collaborations, most frequently between private companies, NGOs or civil society organisations and government actors. Furthermore, while most submissions suggested these partnerships at the national level, some suggested that the collaboration and partnership should occur at the EU level.

4.3.2.9 Digital skills certification, accreditation or assessment

All of the commentary on this topic expressed a positive view on the benefits of certification/accreditation and assessment, and a unified approach across MS was supported. Benefits described in the submissions may be summarised as follows:

- General benefits of digital skills certification for engagement of learners, incentives to upskill or reskill, employability and monitoring purposes
- Beneficial for both teachers and students (self-assessment of digital skills is insufficient)
- Benefits of certification and microcredentials for building links between formal and non-formal education
- Benefits, conditional on mutual recognition across actors, in terms of mobility.

4.3.3 Summary of findings from the submissions to the Call for Evidence

We observed that stakeholders placed varying levels of emphasis on the topics, depending on their perspectives. For example, trade unions placed a high emphasis on digital skills provision outside of formal education relative to the other stakeholder groups; while professional associations mentioned skills gaps more frequently than the other stakeholder groups.

With respect to digital skills education and training outside of formal education settings, the five main themes that emerged under this topic were a need to adapt digital skills training offer content to the needs of individuals, professions, sectors and specific groups; the importance of recognising skills training within overall education and training systems alongside other core skills including problem-solving and soft skills; calls for more focus on the needs of SMEs; calls to leverage existing EU funding and collaboration structures to support provision; and various suggestions to foster links between formal and non-formal education settings.

The content of the submissions regarding digital skills provision in formal settings emphasised a holistic and learner-centred approach. As was the case in Section 3, the central role of the teacher was acknowledged, and concerns expressed about the need to create an appropriate and sustainable system for supporting the continued upskilling of teachers in this regard. Some submissions called for teacher digital skills upskilling in specific areas including AI and data analytics.

Commentary on curricular content and reform included both common and divergent points of view. Commonly held views were that digital skills teaching and learning should be a core part of curricula from an early age; there is a need to modernise primary and secondary curricula; and to support curricular reform, more collaboration is needed between Higher Education and industry. Many of the submissions also recognised the importance of teaching and learning informatics from an early age. Similar to provision outside of formal education settings, the commentary on provision within formal education expressed the view that digital skills should take place alongside, and should be reinforced by, the acquisition of other core skills, including critical thinking and wellbeing. It was also felt that more curricular alignment was needed across the formal education levels, and that HEIs should foster emerging and advanced digital skills in a multi- and inter-disciplinary manner. Some differences in perspectives emerged with respect to the optional or mandatory nature of digital skills subjects; the level of skills to be taught (basic to advanced); and the extent to which formal education curricula should be aligned to the labour market.

Commentary on equity, inclusion and wellbeing tended to reference or prioritise digital skills provision for specific groups, most commonly women, then disadvantaged or vulnerable groups, followed by individuals with disabilities. It was emphasised in some of the submissions that the digital divide is part of a broader social and systemic problem, and others suggested that exchange on best practices for achieving digital inclusion across MS should be encouraged. It was suggested that targets for specific groups should be included and monitored.

Among the comments on networking, collaboration and capacity building, the unifying theme of strengthening co-operation and co-ordination was evident. This was expressed in a variety of ways and referring to various groups and structures, but the common goal underpinning this commentary was a coherent and systematic approach to the provision of digital skills inside and outside of formal education settings.

Unanimously positive views about public-private partnerships were expressed in some of the submissions, and the main focus of this commentary was on the potential benefits of collaboration and partnership between the education sector and industry to meet skills provision needs. Similarly, very positive views were expressed with respect to both digital skills certification and the use of microcredentials. Submissions mentioned some general benefits of digital skills certification in terms of engagement of learners, incentive to upskill or reskill, employability and monitoring purposes; for building links between formal and non-formal education; and for the learning and development of both teachers and students. Some highlighted mobility benefits, conditional on more mutual recognition across actors.

Submissions which mentioned frameworks (mainly DigComp) were favourable towards them and it was suggested to refine and revise the definition of basic skills as well as to develop specific digital skills profiles.

Regarding the digital skills gap, three emerging themes were: a need to foster digital skills in emerging and advanced technologies as well as in specialist areas; that ICT specialist skills can be taught and learned and as a result, recruitment practices should be broadened to 'hire-and-train'; and that there is potential in partnerships between education and industry to achieve this. Holistic approaches and inclusive values were apparent in the commentaries on digital skills gaps.

5 Conclusions and implications

This section provides a short set of conclusions and implications for consideration in the development of the Council Recommendation Proposals on enabling factors for digital education and digital skills provision.

Summaries of the analyses are already provided in Sections 3.1.3, 3.2.3 and 3.3.3 (enabling factors) and 4.1.3, 4.2.3 and 4.3.3 (digital skills).

5.1 Comparisons across the three sources of information

Findings from the RRF and SD are largely consistent with one another. The SD serves to add rich context to the information in the RRF, providing a deeper understanding of enabling factors for digital education ecosystems and digital skills provisions by articulating challenges and priorities which might be considered at the EU level, as well as themes on which exchange between MS may be fruitful.

In both sources of information, we observed similar gaps, which were confirmed as challenging in the SD. These relate to monitoring and evaluation of digital skills and digital education strategies or programmes; assessment of digital skills of various groups, particularly teachers; teacher supply and professional development; shortage of ICT specialists; curricular reform challenges; and some fragmentation in equity and inclusion initiatives particularly in relation to girls and women, and individuals with disabilities.

We also observed considerable diversity across MS in the strategies being deployed to meet these challenges. Perhaps most striking is the diversity in national curricular implementation with respect to digital skills for compulsory schooling. Also remarkable was the variation in the number of digital education and/or digital skills policies within individual MS and the various stages MS are at with respect to whole-of-government approaches to implementing policies in these areas. Other variations were more directly related to the governance structures and economic and demographic variations across MS.

The CfE diverged more from the other two sources, but this is to be expected given the differing perspectives of the various stakeholders. For example, while the submissions to the CfE on digital skills emphasised digital skills certifications and expressed positive views about them, this theme was much less prominent in the SD and RRF sources. Also, cybersecurity concerns were more frequently mentioned in the CfE than in the other two sources, although in both the RRF and SD we saw examples of cybersecurity infrastructure and cybersecurity skills initiatives. This highlights potential differences between the needs of governments and other stakeholders in the digital education and skills ecosystems.

The remainder of this section considers, firstly, what actions might be considered at the European level, as emerging from the analysis of the SD. This is followed by a set of implications arising from all three information sources (RRF, SD, CfE) for consideration transversally (across both Council Recommendation areas) and specific to each Council Recommendation.

5.2 EU-level actions in relation to enabling factors

An analysis of the Structured Dialogue indicates that many MS are seeking opportunities to exchange with one another on the following enabling factors themes:

- CPD, content and solutions for digital pedagogies
- The use of tools and frameworks
- Models for the provision of technical support (through the role of and ICT co-ordinator)
- Higher Education reform initiatives
- Sharing of solutions to technical challenges (e.g. interoperability).

Many MS have sought support from the EC in relation to:

- Awareness-raising and use of common language/terminology and standards in digital education (including alignment in the use of DigComp)
- Support at the EU level in conducting research and gathering evidence in relation to enabling factors
- Funding supports relating to infrastructure and connectivity
- Technical and operational advice or support concerning data privacy, Higher Education reform, and updating of pedagogical content

- Further alignment and connections of various initiatives within and across EU institutions
- Stimulation of partnerships with EdTech and regulation of the EdTech industry
- Regulations and supports for interoperability
- Data privacy policy consolidation.

5.3 EU-level actions in relation to digital skills provision

An analysis of the Structured Dialogue indicates that many MS are seeking opportunities to exchange with one another on the following digital skills themes:

- Reaching remote and vulnerable groups to engage their participation in digital skills training
- Approaches for increasing the share of women in ICT education and ICT professions
- Developing policies that are guided or underpinned by data and evidence
- Responding to rapidly-evolving digital skills needs
- The development of public-private partnerships to support digital skills provision.

Many MS have sought support from the EC in relation to:

- Co-ordination of efforts to address digital skills gaps
- Support for multi-country projects on digital skills provision
- Evaluation of digital skills provision initiatives
- Clarity in the relationships between the various EU-level digital skills bodies, initiatives and funding instruments
- Technical and operational support for the adoption, integration and monitoring of digital skills through microcredentials
- Support for awareness-raising on digital skills, in particular among employer groups (highlighting the need for interaction with labour market actors)
- Support for the implementation of impact assessment in relation to digital skills provision
- Research on, and strategies to tackle the gender gap in ICT
- Support for the development of (psychometric/objective) digital assessment tools for general and specific populations
- Support for forecasting of digital skills supply and demand
- Support for digital skills provision mapping across formal and non-formal education and training systems.

5.4 Conclusions and implications

5.4.1 Transversal

- Across both digital skills provision and enabling factors for digital education, there is a high level of concern about the digital divide, and efforts are being made to address this both through enabling factors and targeted skills provision. Much less is known about the outcomes and impacts of these efforts, and the percentage of individuals with below basic digital skills remains high across the EU. It is recognised that meaningful and successful engagement with individuals requires sustained human resources at the local community level, and the role of intermediate actors should be more strongly acknowledged and strengthened in this respect. It is recommended that the EC continues to support the gathering and sharing of information and evidence on initiatives to tackle the digital divide, and that consideration is given to setting training participation, outcome and impact targets with respect to digital skills for specific priority groups at EU level.
- The gender inequity and low share of women in ICT in both education and employment settings is another area of widespread concern, yet in most MS, the approaches to address this issue are fragmented. It is recommended that the EC supports the gathering of evidence to understand the barriers to female education and employment in ICT fields of study and occupations as well as to support the sharing of good, evidence-based practices to increase the share of girls and women in ICT-related education and employment.

5.4.2 Enabling factors for digital education ecosystems

- Many MS are moving towards whole-of-government comprehensive approaches to policies for digital education. It is recognised that this transition is extremely challenging in terms of complexity, effort, political will and national-regional co-ordination efforts. It is recommended that the EC supports the identification and sharing of good practices of MS on whole-of-government approaches across a diversity of contexts.
- Monitoring and evaluation of enabling factors need to be given a higher priority in digital education policies. It is recommended that the EC supports research on enabling factors for digital education and works with MS to address some challenges and data gaps in relation to the monitoring and evaluation of enabling factors for digital education, including information gaps regarding education system digital infrastructure and device usage.
- There has been significant transformation in teaching and learning since the onset of the pandemic. However, concern has been expressed with respect to the sustainability of CPD, and information on the impacts or outcomes of CPD is lacking in a majority of MS. There is a lower emphasis on CPD in VET and Higher Education than in primary and secondary levels of the formal education system. In the broader context, significant difficulties with teacher supply are being experienced across the EU. It is recommended to reinforce the importance of CPD for both teachers and school leaders in the relevant EU Working Groups, and to consider studies on (i) the emerging challenges and needs of teachers and school leaders and how these might be addressed, and (ii) a review and identification of strategies to tackle the shortage in teacher supply. It is further recommended that the EC supports MS to identify ways in which evaluation and impact assessment may be incorporated into CPD ecosystems.
- Several MS have identified a new role to support schools' digital co-ordinators which play a broader role than that of technical support and maintenance, also involving strategic guidance to school leaders, and mentoring and support to teachers on digital pedagogies. It is recommended that the EC supports MS exchanges on their experiences with respect to the digital co-ordinator role for schools in order to ensure that strategic and pedagogical support needs for digital education, as well as technical maintenance and support needs, are met. One possible way to support this could be through the establishment of a network or Community of Practice of digital education co-ordinators on the Digital Education Hub.

5.4.3 Digital skills provision

- Monitoring and evaluation of digital skills provision both inside and outside of formal education need to be given a higher priority. It is recommended that the EC works with MS to address some challenges and data gaps in relation to the monitoring and evaluation of digital skills provision, in particular in relation to: data on training offers, on the outcomes and impacts of training, and for short and longer-term digital skills supply and demand forecasting.
- Individuals with disabilities and learners with special educational needs are widespread across all of our communities, yet were not strongly featured in the sources examined. It is recommended that the EC supports research on the availability of digital initiatives for these groups to identify any needs for specific digital skills actions.
- Emerging trends on curricula on digital skills show that a combination of transversal and separate-subject approaches is being implemented. MS are moving towards the inclusion of digital skills as a dedicated subject in primary and lower secondary settings, with further specialisations offered in upper secondary. It is recommended that the EC supports MS exchanges on curricular reform and assessment issues, particularly with respect to transversal, separate-subject and mixed approaches, views on informatics as a separate subject, and the role of assessment in these various scenarios. It would also be important to gain a better understanding at the EU level of the needs and priorities of MS with respect to the assessment of digital skills in formal and non-formal education settings. Further collaboration with international organisations involved in the implementation of large-scale international assessments (such as ICILS, PIAAC and PISA) may be helpful in this regard.
- In some MS, public-private partnerships, notably with EdTech companies, have been implemented in innovative ways to help to address a range of digital skills challenges, including the provision of digital skills training; on-the-job training programmes; and improved estimation of digital skills demand and supply. It is recommended that the EC further explore with MS the potential of public-private partnerships for addressing the most acute digital skills needs, and consider regulatory and data privacy aspects of these partnerships.

List of acronyms and abbreviations

AI	Artificial Intelligence
CEDEFOP	European Centre for the Development of Vocational Training
CfE	Call for Evidence
CPD	Continuing Professional Development
DG CNECT	Directorate-General for Communications Networks, Content and Technology
DG EAC	Directorate-General for Education and Culture
DG EMPL	Directorate-General for Employment, Social Affairs and Inclusion
DESI	Digital Economy and Society Index
DigComp	Digital competence framework of the EU
DigCompEdu	Digital competence framework for teachers of the EU
DigCompOrg	Digital competence framework for education institutions of the EU
DS	Digital Skills (provision)
E&T	Education and Training
EC	European Commission
ECFIN	Directorate-General for Economic and Financial Affairs
EF	Enabling factors (for the digital education ecosystem)
ESHA	European School Heads Association
ESSIE2	2nd ICT Survey of Schools in Education (of the EC)
ETM	European Training monitor
EU	European Union
GDPR	General Data Protection Regulation
HEI	Higher Education Institution
ICT	Information and Communications Technologies
ICILS	International Computer Information and Literacy Study (of the IEA)
IT	Information Technologies
ITE	Initial Teacher Education
JRC	Joint Research Centre (of the EC)
MS	Member State(s) of the European Union
PISA	Programme for International Student Assessment (of the OECD)
RDI	Research, Development and Innovation
RF EMF	RadioFrequency ElectroMagnetic Fields
RRF	Recovery and Resilience Facility
SD	Structured Dialogue
SG	Secretariat-General
SG RECOVER	Recovery and Resilience Task Force
SWD	Staff Working Document
SELFIE	Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies
SELFIEforTEACHERS	Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies, for Teachers
TALIS	Teaching and Learning International Survey (of the OECD)
VET	Vocational Education and Training

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ANNEX 4: GLOSSARY AND LIST OF ABBREVIATIONS/ACRONYMS

TERM	DEFINITION
Adaptive learning and teaching	Educational approach that uses digital technology and data to deliver customised learning experiences that address the unique needs of an individual through just-in-time feedback, pathways, and resources[505].
Artificial Intelligence (AI), including generative AI	Information technology systems, either software or hardware based, that display intelligent behaviour by analysing their environment and taking actions - with some degree of autonomy - to achieve specific goals. AI-based systems can be purely software-based (e.g. voice assistants, search engines, speech and face recognition systems, etc.) or embedded in hardware devices (e.g. advanced robots, autonomous cars, drones, etc.)[506]. Traditional AI systems are designed to recognize patterns and make predictions, whereas generative AI is able to generate new content based on the data they have been trained on[507].
Assistive Technologies (AT)	Technologies, either advanced (e.g. Braille applications, smart canes, haptic computers) or relatively low-tech (e.g. glasses, crutches, hearing aids), designed to support people with disabilities[508].
Blended learning	Pedagogical approach mixing face-to-face and online learning, with some element of learner control over time, place, path, and pace[509]. In the formal education sector, the term refers to when a school, educator or learner takes more than one approach to the learning process[510].
Critical infrastructures	Include power grids, the transport network and information and communication systems. Protection of these infrastructures is vital for the security of the EU and the well-being of its citizens[511].
Computational Thinking	Shorthand for 'thinking as a computer scientist', the tem refers to the ability to understand the underlying notions and mechanisms of digital technologies to formulate and solve problems[512].
Computer Science	See Informatics.
Connectivity (fibre, 5G, satellite)	The ability of a computer, program, device, or system to connect with one or more others. There are different connection types that use different technologies, such as fibre, 5G and satellite. Each technology

[505] Graf S., Fuhua L., Kinshuk, McGreal R. (2011) Intelligent and Adaptive Learning Systems: Technology Enhanced Support for Learners and Teachers.
[506] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions: Artificial Intelligence for Europe. COM(2018) 237 final.
[507] Technopedia (2022). Generative AI. Avaiable at : https://www.techopedia.com/definition/34633/generative-ai
[508] European Parliamentary Research Service - Scientific Foresight Unit (2018). Assistive technologies for people with disabilities.
[509] Lifelong Learning Platform (2019). Lexicon. Available at http://lllplatform.eu/resources/lexicon/
[510] Council Recommendation on blended learning approaches for high-quality and inclusive primary and secondary education - 2021/C 504/03.
[511] EU Science Hub (2022). Critical infrastructure protection.
[512] European Commission (2016). Developing computational thinking in compulsory education. JRC Science for Policy Report.

	offers a different level of speed or bandwidth (e.g. the speed that data is transferred between a device and the internet)[513].
Cybersecurity	Measures adopted to defend information systems from external unauthorized access as well as user actions that compromise the confidentiality, integrity and availability of both information and systems[514].
Data protection	The processes and mechanisms designed to protect individual privacy rights regarding the collection, storing, handling, processing and the dissemination of data[515].
Data standards	A technical specification that describes how data should be stored, managed and/or exchanged to ensure the accessibility, retrievability, accessibility, sustainability and interoperability of these data across different systems, tools, platforms, etc. [516].
Deep Tech	An institution, an organisation or a start-up company, with the expressed objective of providing disruptive solutions built around unique, protected or hard-to-reproduce technological or scientific advances. These solutions are defined by their complexity, both in terms of the science that underpins them and the IP they generate, often having a long development time, significant capital requirements and challenging regulatory barriers to overcome[517].
Digital capacity/ preparedness/readiness	Ability to integrate, optimise and transform digital technologies in different processes and activities, including planning for organisational change, ongoing monitoring and adaptation, and a strong focus on learning driven pedagogy[518].
Digital citizenship	Set of values, skills, attitudes, knowledge and critical understanding citizens need in the digital era A digital citizen knows how to use technologies and is able to engage competently and positively with them. He/she participates actively and responsibly in both on- and offline communities at all levels[519].
Digital competence	Ability to confidently, critically and responsibly use and engage with digital technologies for learning, work, and participation in society[520]. The European Digital Competence Framework has identified the key components of digital competence in five areas: information and data

[513] European Commission (2019). 2nd Survey of Schools: ICT in Education. Luxembourg: Publications Office of the European Union.
[514] ENISA (2018). Cybersecurity culture guidelines: behavioural aspects of cybersecurity.
[515] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L 119, 4.5.2016.
[516] Common Education Data Standards
[517] Romasanta A., Ahmadova G., Wareham J. D., Pujol Priego L. (2021). Deep tech: Unveiling the foundations. For further details see also: What is Deep Tech?
[518] Commission Staff Working Document accompanying the Digital Education Action Plan 2021-2027- SWD(2020) 209 final.
[519] Council of Europe (2019). Digital Citizenship Education Handbook.
[520] Council Recommendation of 22 May 2018 on Key Competences for Lifelong learning - 2018/C 189/01.

	literacy; communication and collaboration; digital content creation; safety; and problem solving[521].
Digital divide/gap	Differences between individuals, households, businesses and geographic areas at different socio-economic levels with regard to both access and use of technology[522]. The term is also used to indicate differences in the level of digital skills and the mismatch between the demand-supply of digital skills[523].
Digital education	Digital education comprises of two different but complementary perspectives: 1) the pedagogical use of digital technologies to support and enhance teaching, learning and assessment and 2) the development of digital competences by learners and education and training staff[524].
Digital education content	Pedagogical content created, produced and delivered in different digital formats and by using digital tools with the explicit intention of supporting learners and teachers' educational activities[525].
Digital Education Hackathon (DigiEduHack)	One of the flagship initiatives of the European Commission on digital education. DigiEduHack engages educational institutions and other organisations working in the education field in a 'contest' to identify key challenges and co-create solutions across disciplines and organisations on digital education matters[526].
Digital Education Hub	Open online collaborative community on digital education for stakeholders from all levels and sectors of education and training in Europe and beyond. It is part of the Digital Education Action Plan 2021-2027 and aims for reinforced cooperation and dialogue between stakeholders in the area of digital education[527].
Digital education solutions	A system that considers both social and technical aspects to solve a real-world [educational] problem with digital means[528].
Digital inclusion	Activities necessary to ensure that all individuals and communities, including the most disadvantaged ones, can contribute to and benefit from the digital transformation[529]. It requires strategies and investments to reduce and eliminate historical, institutional and structural barriers to access and use of technology[530]. Concerning digital education, it centres around leveraging digital tools to widen

[521] Joint Research Centre (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. Luxembourg: Publications office of the European Union.
[522] OECD (2006). Understanding the digital divide. Available at https://stats.oecd.org/glossary/detail.asp?ID=4719
[523] Centeno C., Karpinski Z., M.C. Urzi Brancati (2022). Supporting policies addressing the digital skills gap. Luxembourg: Publications Office of the European Union.
[524] European Commission (2019) Digital Education at School in Europe. Luxembourg: Publications Office of the EU.
[525] Commission Staff Working Document accompanying the Digital Education Action Plan 2021-2027- SWD(2020) 209 final.
[526] DigiEduHack
[527] European Education Area: European Digital Education Hub
[528] Glinz M., Lauenroth K. (2021). A Glossary of the Terminology for the Digital Design Professional.
[529] Digital strategy on digital inclusion
[530] European Commisssion (2019). Digital Inclusion & Web Accessibility in the European Union: Essential for some, useful for all. Luxembourg: Publications Office of the European Union

	access and enhance the quality of teaching and learning for the purpose of delivering a fair and equitable education[531].
Digital infrastructure	Digital infrastructure refers to the structures (physical or virtual) that act as enablers for technological developments and access to ICT. Includes hardware, software as well as digital equipment[532].
Digital integrators	Term used to describe a wide range of professionals and sector specialists with advanced digital skills[533].
Digital literacy	The ability to access, manage, understand, integrate, communicate, evaluate, create, and disseminate information safely and appropriately through digital technologies. It includes competences that are variously referred to as information literacy, media literacy, computer, and ICT literacy. Digital literacy involves a dimension of active and civic engagement with the digital world, promotes active citizenship[534] and is part of being digitally competent.[535]
Digital Pedagogy	The meaningful use of digital technologies in the teaching and learning practices with the intent to support personalised learning, contribute to the design of new modes of learning, enrich existing learning experiences and improve learning outcomes[536].
Digital skills (basic, advanced, specialist)	Set of skills that enable individuals to understand how technology can support communication, creativity and innovation, and be aware of their opportunities, limitations, effects and risks. Basic digital skills allow a basic ability to use digital devices and online applications (for instance to access, filter and manage information, create and share content, communicate and collaborate), and are considered a critical component of a new set of literacy skills in the digital era, with reading, writing, and numeracy skills[537]. At the advanced end of the spectrum of digital skills are the higher-level abilities that allow individuals to make use of digital technologies in empowering and transformative ways, such as professions in ICT[538]. Advanced digital skills are specialised skills, i.e. skills in designing, developing, managing and deploying technologies such as high performance computing, artificial intelligence and cybersecurity at ISCED level 4 and above[539].

[531] European Commission (2021). Enhancing learning through digital tools and practices: how digital technology in compulsory education can help promote inclusion : final report, Luxembourg: Publications Office of the EU.
[532] Digital Compass: the European way for the Digital Decade - COM(2021) 118 final.
[533] Kompetence Barometer
[534] European Commission (2022). Guidelines for teachers and educators on tackling disinformation and promoting digital literacy through education and training, Publications Office of the European Union.
[535] Joint Research Centre (2017). DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use. Luxembourg: Publications office of the European Union.
[536] Commission Staff Working Document accompanying the Digital Education Action Plan 2021-2027- SWD(2020) 209 final
[537] Council Recommendation of 22 May 2018 on key competences for lifelong learning. 2018/C 189/01.
[538] UNESCO (2018) Digital skills critical for jobs and social inclusion.
[539] Proposal for a Regulation of the European Parliament and of the Council establishing the Digital Europe programme for the period 2021-2027. COM/2018/434 final - 2018/0227.

Digital Skills and Jobs Coalition (DSJC) and Platform (DSJP)	The DSJC is an EU initiative bringing together Member States, companies, social partners, non-profit organisations and education providers, who work to address the lack of digital skills in Europe. DSJP is the platform where members meet, exchange and keep up to date with European initiatives and policy actions on digital skills[540].
Digital transition/ transformation	The terms are often used as synonymous. However, digital transition (digitisation) refers to the conversion of information or data from analogue to digital format, whereas digital transformation (digitalisation) refers to the adoption or increase in use of digital technology by an organisation, an industry, or a country and therefore describes more generally the way digitisation is affecting economy and society[541].
Digital well-being	Digital well-being refers to the overall well-being in digital environments, with the aim to safeguard and ensure a culture of a meaningful and ethical use of digital tools with a view to ensure that technology is used in a positive way and also with the aim to act safely and responsibly in digital environments[542].
Disinformation/misinformation	Disinformation is verifiably false or misleading information that is created, presented, and disseminated for economic gain or to intentionally deceive the public. Misinformation is verifiably false information that is spread without the intention to mislead, and often shared because the user believes it to be true[543].
Educational Technology (EdTech)	The industry that combines education and technological advances as well as the scientific field, which involves the interdisciplinary knowledge informing the use of digital tools and devices, processes and procedures, resources and strategies to improve learning experiences in a variety of learning settings[544].
Education and Training Monitor	A comparative report that presents the European Commission's annual analysis of how education and training systems evolve across the EU[545].
Enabling Factors	The term is used to reference elements that are necessary for the development of a high-performing and inclusive digital education and training ecosystem that serves the needs of all learners. They include elements of technological capacity, human resources, as well as strategies and policies.
EU Code Week	Initiative supported by the European Commission that encourages citizens (students, teachers, young adults, parents, etc.) to learn about technology and coding[546].

[540] Digital Skills and Jobs Coalition I Digital Skills and Jobs Platform (europa.eu)
[541] OECD (2017). Going Digital: Making the Transformation Work for Growth and Well-Being. Paris: OECD publishing.
[542] Council conclusions on supporting well-being in digital education, 2022 O.J. (C 469/04)
[543] European Commission (2022). Guidelines for teachers and educators on tackling disinformation and promoting digital literacy through education and training. Luxembourg: Publications Office of the European Union.
[544] Huang R., Spector J.M., Yang J. (2019). Introduction to Educational Technology. In R. Huang J.M. Spector, J. Yang (Eds.), Educational Technology: A Primer for the 21st Century. Singapore: Springer.
[545] European and Training Monitor
[546] Europe Code Week

Formal, non-formal and informal education	Formal education is education that is intentional, organised and structured. It is usually provided in schools, colleges, universities and other formal education and training institutions, and leads to recognised diplomas and qualifications. Non-formal education takes place through planned activities (in terms of learning objectives and learning time) where some form of learning support is present, but which is not part of the formal education and training system. Informal education results from daily activities related to work, family or leisure which is not organised or structured in terms of objectives, time or learning support[547].
Hybrid learning	Educational approach where students can choose how to attend a specific class or learning opportunity, either in-person. Educators teach remote and in-person students at the same time using tools like video conferencing hardware and software[548].
ICT specialist	Professionals that deal with developing, operating and maintaining information technology systems[549]. A narrower definition include only those whose jobs solely concern ICTs (programmers, software engineers, etc.)[550].
Individual learning accounts	Virtual individual accounts in which training rights are accumulated over time They can be used for further training, guidance or validation[551].
Informatics/computer science	A distinct scientific discipline, characterised by its own concepts, methods, body of knowledge, and open issues. It covers the foundations of computational structures, processes, artefacts and systems, and their software designs, their applications, and their impact on society[552].
Information and Communication Technology (ICT)	Diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the internet, live broadcasting technologies, recorded broadcasting technologies and telephony[553].
Interoperability	The ability of two or more distinct systems or components to exchange information and to use the information that has been exchanged seamlessly, securely and in a controlled manner[554].

[547] Erasmus + Programme Guide (2020). Annex III- Glossary of terms.
[548] E-learning industry (2022). Hybrid learning in education. Available: https://elearningindustry.com/hybrid-learning-in-education
[549] Eurostat (2022): Statistic explained - Eurostat (europa.eu): ICT specialists in employment.
[550] OECD (2004). OECD Information Technology Outlook. Paris: OECD publications
[551] Council Recommendation of 16 June 2022 on individual learning accounts - 2022/C 243/03
[552] CECE (2017). Informatics Education in Europe: Are we all in the Same Boat?
[553] UNESCO Institute for Statistics (2020). Glossary.
[554] Bates DW, Samal L. (2018). Interoperability: What Is It, How Can We Make It Work for Clinicians, and How Should We Measure It in the Future? Health Serv Res. 2018 Oct;53(5):3270-3277.

International Standard Classification of Education (ISCED)	A statistical framework for organising information on education. It has nine levels: ISCED 0 refers to early childhood education, ISCED 1 to primary education, ISCED 2 to lower secondary education, ISCED 3 to upper secondary education, ISCED 4 to post-secondary non-tertiary education, ISCED 5 to short-cycle tertiary education, ISCED 6 to bachelor's or equivalent level, ISCED 7 to master's or equivalent level, ISCED 8 to doctoral or equivalent level[555].
Learning analytics	The measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs[556].
Learning Management System (LMS)	A web-based software platform made for delivering, tracking and managing online and blended learning. Its main features allow handling all aspects of the learning process beyond content delivery (e.g. course management, learners' enrolment, online activity tracking, etc.)[557].
Learning outcomes (including learning objectives)	Statements of what a learner knows, understands and is able to do on completion of a learning process in formal, non-formal or informal education. Learning outcomes indicate actual attainment levels, while learning objectives define the competences to be developed in general terms[558].
Lifelong learning	All activities undertaken throughout life, with the aim of improving knowledge, skills and competences for personal, civic, social and/or professional reasons[559]. It covers education and training across all ages and in all areas of life - be it formal, non-formal or informal[560].
Metaverse	A conceptual term that captures a mix of virtual reality and other technologies. It is a world of interconnected physical and virtual communities where users can develop professionally, socialise, entertain, commerce and trade with virtual properties[561].
Micro-credentials	The record of the learning outcomes that a learner has acquired following a small volume of learning. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, and cultural or labour market needs. Micro-credentials can be used to complement and enhance education, training, lifelong learning and employability ecosystems[562].

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[557] Watson W., Watson S. L. (2007). An Argument for clarity: what are learning management systems, what are they not and what should they become. TechTrends, 51(2), 28–34.
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[561] O'Brien, M. & Chan, K. (2021). Explainer: What is the metaverse and how will it work? Los Angeles Times.
[562] Council Recommendation on a European approach to micro-credentials for lifelong learning and employability.

Online learning	Also known as ICT-based learning, virtual learning and e-learning, the term indicates a methodology involving the use of ICTs to support both teaching and learning[563].
Play-based Learning	Pedagogical approaches where children can explore, experiment, discover, and solve problems in imaginative and playful way[564].
Reality: Augmented (AR) - Virtual (VR) - Mixed (MR) – Extended (XR)	AR is an interactive experience where real-world environments and objects are supplemented by computer-generated 3D models and animated sequences, which are displayed as if they are in a real-world environment[565]. VR is a computer-generated scenario that simulates a real-world experience that can be experienced by using special electronic equipment, such as a VR headset or gloves fitted with sensors. MR features elements of both AR and VR. Its key characteristic is that the objects and content from both the virtual and real-world are able to react to each other in real time[566]. XR is a catch-all term for Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR)[567].
Remote or distance education	Method of delivery, which involves teaching and learning activities where educators and learners are not physically present in one location at the same time. Learning happens instead away from the physical site of an educational provider with educators and learners using different means to engage with a programme, course or educational activity[568].
Student information system	A software that enables education and training institutions to digitize and consequently manage student information more efficiently, including but not limited to grades, attendance records, and more[569].
Technological sovereignty	The ability of a country (or a group of countries) to generate autonomously technological and scientific knowledge or to use technological capabilities developed outside by using reliable partnerships[570].
Unplugged Digital Education Activities	Educational activities that promote the development of digital skills without using digital devices[571].

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[564] Parker, R., Thomsen, B. S., & Berry, A. (2022). Learning Through Play at School: A Framework for Policy and Practice.
[565] European Commission (2022). Ethical guidelines on the use of artificial intelligence and data in teaching and learning for educators. Luxembourg: Publications Office of the European Union.
[566] European Commission (2022). Ethical guidelines on the use of artificial intelligence and data in teaching and learning for educators. Luxembourg: Publications Office of the European Union.
[567] ECORYS (2021). XR and its potential for Europe. Available at https://xreuropepotential.com/assets/pdf/ecorys-xr-2021-report.pdf
[568] QAA Guidance (2020). Building a Taxonomy for Digital Learning. Available at: https://www.qaa.ac.uk/news-events/news/qaa-publishes-building-a-taxonomy-for-digital-learning
[569] EDUCASE (2022). Student Information Systems.
[570] Crespi F., Caravella S., Menghini M., Salvatori C. (2021). European Technological Sovereignty: An emerging framework for policy strategy. Intereconomics, 56(6), 348-354.
[571] Poulakis, E., & Politis, P. (2020). Teaching Computational Thinking Unplugged: A Review of Tools and Methodologies. Handbook of Research on Tools for Teaching Computational Thinking in P-12 Education, 200-236.

Virtual administration/management system	Web-based software that interfaces with virtual environments and the underlying physical hardware to simplify resource administration, enhance data analyses, and streamline operations[572].
Upskilling/reskilling	Short-term targeted training typically provided following initial education or training, and aimed at supplementing, improving or updating knowledge, skills and/or competences acquired during previous training. Reskilling enables individuals to acquire new skills giving access either to a new occupation or to new professional activities[573].
Virtual Learning Environment (VLE)	A learning situation that is supported by Internet-enabled technologies to provide virtual tools for students to learn specific content, communicate and submit work, while providing components for an instructor to manage the learning process, collect input, and provide feedback to students[574].

[572] Sutherland L., Janene-Nelson K. et al. (2018). Work Together Anywhere: A Handbook on Working Remotely Successfully for Individuals, Teams, and Managers.
[573] CEDEFOP (2008). Terminology of European education and training policy. A selection of 100 key terms.
[574] Spector J. M. (2015). The SAGE Encyclopedia of Educational Technology. SAGE Publications.

List of abbreviations and acronyms

- ACVT - Advisory Committee on Vocational Training
- AI – Artificial Intelligence
- AMS - Administrative Management Systems
- AR – Augmented Reality
- AT - Assistive Technologies
- CAD - Computer-Aided Design
- CAM - Computer-Aided Manufacturing
- CDP - Continuous Professional Development
- CfE - Call for Evidence
- CR - Council Recommendation
- DELTA - Working Group on Digital Education: Learning Teaching and Assessment
- DESI - Digital Economy and Society Index
- DG CNECT - Directorate-General Communications Networks, Content and Technology
- DG EAC - Directorate-General for Education, Youth, Sport and Culture
- DG EMPL - Directorate-General for Employment, Social Affairs and Inclusion
- DGVT - Directors General for Vocational Training
- DSJC - Digital Skills and Jobs Coalition
- DSJP - Digital Skills and Jobs Platform
- ECEC - Early Childhood Education and Care
- EQAVET - European Quality Assurance in Vocational Education and Training
- GDPR - General Data Protection Regulation
- ICILS - International Computer and Information Literacy Study
- ICT - Information and Communication Technology
- ISCED - International Standard Classification of Education
- ITE - Initial Teacher Education
- IVET - Initial Vocational Education and Training
- JRC - Joint Research Centre
- KPIs - Key Performance Indicators
- LMS - Learning Management Systems
- MR – Mixed Reality
- OPC - Open Public Consultation
- PIAAC- Programme for the International Assessment of Adult Competencies
- PISA – Programme for International Student Assessment
- SMEs- Small and Medium Enterprises
- TALIS - Teaching and Learning International Survey
- TSI - Technical Support Instrument
- VET - Vocational Education and Training
- VLE - Virtual Learning Environment
- VR – Virtual Reality
- XR – Extended Reality

ANNEX 5: LITERATURE AND SOURCES

The present Annex presents recent research reports and literature on digital education and skills. The full list of resources used to write the Staff Working Document is provided in the document's footnotes.

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Bejaković P., Mrnjavac Ž. (2020). The importance of digital literacy on the labour market. Employee Relations: The International Journal.

Ben Youssef A., Dahmani M., Ragni L. (2022). ICT use, digital skills and students' academic performance: Exploring the digital divide. Information, 13(3), 129.

Bocconi S., Chioccariello A., Kampylis P., Dagienė V., Wastiau P., Engelhardt K., Earp J., Horvath M.A., Jasutė E., Malagoli C., Masiulionytė-Dagienė V., Stupurienė G. (2022). Reviewing Computational Thinking in Compulsory Education. Luxembourg: Publications Office of the European Union.

Boeren E., Roumell E.A., Roessger K.M. (2020). COVID-19 and the future of adult education: An editorial. Adult Education Quarterly, 70, 3.

Cachia, R., Velicu, A., Chaudron, S., Di Gioia, R. and Vuorikari, R. (2021). Emergency remote schooling during COVID-19, EUR 30866 EN. Luxembourg: Publications Office of the European Union.

Castaño Muñoz, J., Pokropek A. and Weikert García L. (2022). For to all those who have, will more be given? Evidence from the adoption of the SELFIE tool for the digital capacity of schools in Spain.

Cateté V., Alvarez L., Isvik A., Milliken A., Hill M., Barnes T. (2020). Aligning Theory and Practice in Teacher Professional Development for Computer Science. Proceedings of the 20th Koli Calling International Conference on Computing Education Research (Koli Calling '20). New York: Association for Computing Machinery.

CEDEFOP (2022). Teachers and trainers in a changing world: building up competences for inclusive, green and digitalised vocational education and training (VET): synthesis report. Luxembourg: Publications Office of the European Union.

CEDEFOP (2022). Evidence supporting the upcoming proposal for a Council Recommendation on improving the provision of digital skills in education and training. Draft working paper.

CEDEFOP (2021). Digital skills: challenges and opportunities during the pandemic. Luxembourg: Publications Office of the European Union.

CEDEFOP (2020). Empowering adults through upskilling and reskilling pathways. Volume 1: adult population with potential for upskilling and reskilling. Luxembourg: Publications Office of the European Union.

CEDEFOP (2020). Key competences in initial vocational education and training: digital, multilingual and literacy. Luxembourg: Publications Office of the European Union.

CEDEFOP (2020). Challenging digital myths: first findings from Cedefop's second European skills and jobs survey. Policy brief. Luxembourg: Publication Office of the European Union.

Centeno C., Karpinski Z., Urzi Brancati C. (2022). Supporting policies addressing the digital skills gap. Identifying priority groups in the context of employment. Luxembourg: Publications Office of the European Union.

Clancy S., Studená I., Vatrella S. (2020). The Upskilling Pathway. In Europe's Lifelong Learning Markets, Governance and Policy. New York: Palgrave Macmillan.

Codagnone, C., Liva, G., Gunderson, L., Misuraca, G., Rebesco, E., (2021). Europe's Digital Decade and Autonomy. Luxembourg: European Parliament.

Costa, P., Castaño-Muñoz, J. and Kampylis P. (2021), Capturing schools' digital capacity: Psychometric analyses of the SELFIE self-reflection tool.

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Di Pietro G., Biagi, F., Dinis Mota Da Costa P., Karpinski Z. Mazza, J. (2020). The likely impact of COVID-19 on education: Reflections based on the existing literature and recent international datasets. Luxembourg: Publications Office of the European Union.

Dimitrova A. (2021). COVID-19 showed us that adapting education and training to the digital age is a task for the whole society. TheMayor.eu.

Engelhardt K. (2021). The future of school beyond COVID-19, 2020-21. Brussels: European Schoolnet.

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European Commission (2022). Ethical guidelines on the use of artificial intelligence and data in teaching and learning for educators. Luxembourg: Publications Office of the European Union.

European Commission (2020). Innovation & digitalisation: a report of the ET 2020 Working Group on Vocational Education and Training (VET): EIGHT insights for pioneering new approaches. Luxembourg: Publications Office of the European Union.

European Commission (2022) Digital Economy and Society Index (DESI) 2022 - Digital Infrastructure.

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European Commission (2022). Education and Training Monitor 2022. Comparative report. Luxembourg: Publications Office of the European Union.

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International Telecommunications Union (2020) Digital Skills Assessment Guidebook.

Informatics for All coalition (2022) Informatics reference framework for school.

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Martin F., Polly D., Coles S., Wang C. (2020). Examining higher education faculty use of current digital technologies: importance, competence, and motivation.

Minea-Pic A. (2020). Innovating teachers' professional learning through digital technologies, OECD Education Working Papers, No. 237, Paris: OECD Publishing.

OECD (2023/forthcoming). Shaping the future of digital education: enabling factors for quality, equity and efficiency. Paris: OECD.

OECD (2021) Teachers and Leaders in Vocational Education and Training, OECD Reviews of Vocational Education and Training. Paris: OECD Publishing.

OECD (2021) OECD Digital Education Outlook 2021: Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots. Paris: OECD Publishing.

OECD (2021) Adult learning and COVID-19: how much informal and non-formal learning are workers missing? Paris: OECD Publishing

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