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Mapping DigComp digital competences to the ESCO skills framework for analysis of digital skills in EU online job advertisements

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Contents

Abstract

This study maps the DigComp framework (European Digital Competence Framework for citizens) to the skills descriptors of ESCO (European Skills, Competencies, Qualifications and Occupations), the classification of skills which is used in the Skills-OVATE, the database of European online job advertisement (OJA). This experimental mapping allows to reconcile the "demand side" of digital skills sought by employers with the "supply side" of education and training for digital skills, through the lens of DigComp, which is used in many EU digital skills initiatives at international, national and regional levels. To date, out of nearly 14,000 skills listed in ESCO, 2,670 have been detected in OJA data. We find that 732 of ESCO skills map to one or more DigComp competences accounting for 54.5% of all skills mentioned in Skills-OVATE OJA between 2018 and 2022. However, coverage across DigComp competence area is uneven, with a higher emphasis on information and data literacy; content creation; and communication and collaboration, than on safety (which includes data protection and privacy, and environmental sustainability) or problem-solving. In line with existing research, DigComp-related skills are more often found in job advertisements of "white-collar" occupations, than of the other occupation groups. The extent to which DigComp-mapped ESCO skills descriptors are explicitly or implicitly in digital environments varies across DigComp competences. For example, information and data literacy skills were more likely to feature explicit digital environments than communication and collaboration skills. Some implications for the developers and users of the three sources of information are considered.

Acknowledgements

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Executive summary

Policy context

The European Union (EU) policy agenda places a high priority on the development of digital skills and competences. This is reflected in a range of policies and initiatives, such as the 2020 European Skills Agenda[1], the European Pillar of Social Rights Action Plan[2], the Digital Decade Policy Programme[3], and the Digital Education Action Plan 2021-2027[4]. The latter includes actions in relation to a Council Recommendation improving the provision of digital skills and competences in (formal, informal and non-formal) education and training[5], and the European Digital Skills Certificate (EDSC) feasibility study[6].

Ambitious EU targets have been set in relation to digital skills. For example, in the Digital Decade Policy Programme, at least 80% of those aged 16-74 should have at least basic digital skills by 2030, and 20 million ICT specialists should be employed by 2030.

A key challenge for European skills policy is to understand what digital skills are needed, for which jobs and what support mechanisms needs to be put in place. To help with this, various skills intelligence tools are available. For example, at the European level, Cedefop (European Centre for the Development of Vocational Training) offers a regularly updated online interactive dashboard using online job advertisement (OJA) [7].

This exploratory study aims to provide a bridge between the supply and demand of digital skills, taking a generalist (rather than information and communications technologies (ICT) specialist) perspective. It does so by measuring the type and prevalence of digital competences required in OJA in the EU through the lens of DigComp 2.2, the fourth iteration of the European Digital Competence framework for citizens (Vuorikari et al., 2022).

Key conclusions

Digital skills, as classified under DigComp competences, are highly represented in the European Skills, Competences, Qualifications and Occupations (ESCO) classification system, and in the online job advertisement (OJA) database, Skills-Online Vacancy Analysis Tool for Europe (Skills-OVATE). This confirms the high demand of non-ICT-specialist skills in the labour force (at least from the perspective of OJA) and the exploratory approach, if validated, could represent a methodology for monitoring and responding to non-specialist digital skills needs.

The uneven coverage of DigComp competences have implications for all three sources of information used. The very low emphasis on DigComp safety-related competences in ESCO and Skills-OVATE is a potential cause for concern and deserves further exploration. Regarding Skills-OVATE**,** findings suggest that there would be benefit in OJA to be more specific about whether or not tasks are executed in digital environments as well being more specific about digital skills requirements in relation to data privacy and security. Regarding ESCO, the uneven coverage of DigComp competences observed is confirmed at least for the skills that appeared in OJA; a complete mapping to the 14,000 ESCO skills would be needed to confirm if the same imbalance is observed in ESCO overall.

Main findings

Of some 14,000 skills in ESCO, 2,670 appear in one or more OJA in Skills-OVATE. Of these 2,670, 27% map to at least one of the DigComp competences. DigComp-mapped skills account for 54.5% of all skills occurrences in Skills-OVATE OJA (2018-2022).

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[1] https://eufunds.ie/european-social-fund/operational-programmes/esf-2021-2027/european-skills-agenda/#:~:text=The%20new%20European%20Skills%20Agenda,becomes%20a%20reality%20across%20Europe

[2] https://ec.europa.eu/social/main.jsp?catId=1607&langId=en

[3] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en#the-path-to-the-digital-decade

[4] https://education.ec.europa.eu/focus-topics/digital-education/action-plan

[5] https://www.consilium.europa.eu/en/press/pressreleases/2023/11/23/digit al-skills-and-competences-and-successful-digital-education-and-trainingfit-for-the-digital-era/

[6] https://joint-research-centre.ec.europa.eu/digcomp/european-digital-competence-certificate-edsc_en

[7] https://www.cedefop.europa.eu/en/tools/skills-online-vacancies/

Both ESCO and OJA place an uneven emphasis on DigComp competences. There is a relatively high emphasis on information and data literacy; digital content creation; and communication and collaboration, and a relatively low emphasis on problem solving, with almost no coverage of safety competences (which include wellbeing, environmental sustainability, device and data protection and privacy).

There is also variation in the extent to which DigComp competences are referenced in an explicit digital environment or not. For example, information and data literacy skills were more likely to feature explicit digital environments than communication and collaboration skills.

In line with expectations, the distribution of DigComp-mapped skills featuring in OJA across occupation groups indicates greatest demand in occupations in the Managers, Professionals, Technicians and Associate Professionals, and Clerical and Support Workers groups.

Related and future JRC work

Development work on DigComp by the JRC envisaged during 2024-2025 foresees the production of a set of indicative learning outcomes. Linking these learning outcomes in the future to ESCO could provide help to strengthen the bridge between supply and demand of digital skills.

There is a need to consider whether adaptations to survey-based measures of digital skills supply could support alignment between supply and demand. DigComp might provide a unifying framework for this purpose, when it comes to non-specialist digital skills.

Quick guide

Section 1 provides the policy context, background, and aims of the present study.

Section 2 provides an overview of the frameworks and data (i.e. DigComp, ESCO and Skills-OVATE) used for the analyses.

Section 3 details the methodology and caveats associated with the data and analyses.

Section 4 provides the results of the mapping analysis.

Section 5 offers some conclusions and considers the implications for future work.

1 Introduction

1.1 Policy context and background

In recent years, fostered also by the Covid-19 pandemic, a growing number of sectors and occupations have been rapidly experiencing a digital transformation, resulting in growing demand for digital skills in information and communications technologies (ICT) – as well as non-ICT jobs (Cedefop, 2023). In Europe, more than 90% of professional roles require a basic level of digital knowledge, just as they require basic literacy and numeracy skills. The use of digital technologies is spreading across all sectors, from business to transport to farming. Yet, in 2021, around 42% of European adults (and 37% of those in the workforce) lack basic digital skills[8,9].

The EU policy agenda accords a high strategic priority to the development of digital skills and competences. This is as reflected in a range of policies and initiatives, for example the 2020 European Skills Agenda[10], the European Pillar of Social Rights Action Plan[11], the Digital Decade Policy Programme[12], and the Digital Education Action Plan 2021-2027[13]. Under Digital Education Action Plan, the Council of the EU adopted in November 2023 a set of recommendations on the key enabling factors for successful digital education and training, and on improving the provision of digital skills and competences in (formal, informal and non-formal) education and training (Council of the European Union, 2023).[14] on the topic of digital education and skills took place with in-depth bilateral meetings being held with all 27 EU Member States during 2022. The evidence gathered has informed these Council Recommendations[15]. [16], and drawing on the conclusions of the European Digital Skills Certificate (EDSC) feasibility study[17]. The inclusion of a pilot of key building block for an EDSC as a flagship initiative and the high level of emphasis given to digital skills in the European Year of Skills[18] are also indicative of the high level of policy attention to this topic.

EU policy has included the setting of targets to encourage Member States to step up efforts in terms of digital skills to seize the opportunities of the digital transition. The European Skills Agenda set the ambitious objective of 70% of 16-74 year olds having at least basic digital skills by 2025, and the European Social Pillar Action Plan the target that at least 80% of those aged 16-74 should have basic digital skills by 2030, in line also with the Digital Decade Policy Programme[19], which in turn added the target of 20 million ICT specialists employed by 2030.

A key challenge for European skills policy is to understand what digital skills are needed, and for which jobs. Providing information in (quasi) real-time, online labour market data have great potential to improve policymakers' understanding of trends in skills needs and supply to support governments in developing more targeted skills policy interventions (Cedefop, European Commission, ETF, ILO, OECD, and UNESCO, 2021). Previous studies have explored the potential of online job advertisements (OJA) to track the trends in the demand for digital skills (e.g., Borgonovi et al., 2023; Cedefop, 2023; Sostero and Tolan, 2022), while others have focused on the supply side providing evidence on the academic offer of advanced digital skills in the EU in a comparative perspective (e.g., Gómez Losada et al., 2020; Righi et al., 2020, 2022; European Commission,

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[8] https://digital-strategy.ec.europa.eu/en/policies/digital-skills#:~:text=Yet%2C%20around%2042%25%20of%20Europeans,of%20those%20in%20the%20workforce

[9] https://digital-strategy.ec.europa.eu/en/policies/digital-skills-and-jobs

[10] https://eufunds.ie/european-social-fund/operational-programmes/esf-2021-2027/european-skills-agenda/#:~:text=The%20new%20European%20Skills%20Agenda,becomes%20a%20reality%20across%20Europe

[11] https://ec.europa.eu/social/main.jsp?catId=1607&langId=en

[12] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en#the-path-to-the-digital-decade

[13] https://education.ec.europa.eu/focus-topics/digital-education/action-plan

[14] The Structured Dialogue was co-ordinated by Secretariat-General (SG) and implemented in close cooperation by 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). https://digital-skills-jobs.europa.eu/en/structured-dialogue-digital-education-and-skills

[15] The JRC (T1, Digital Education and Skills team) has completed an in-depth thematic analysis of the Structured Dialogue to support the Staff Working Document associated with these Council Recommendations. See Annex 3 of the Staff Working Document for the JRC report: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A205%3AFIN

[16] https://ec.europa.eu/social/BlobServlet?docId=26795&langId=en

[17] The final report on the EDSC feasibility study is in preparation. https://joint-research-centre.ec.europa.eu/digcomp/european-digital-competence-certificate-edsc_en.

[18] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-year-skills-2023_en

[19] https://digital-strategy.ec.europa.eu/en/library/digital-decade-policy-programme-2030

Joint Research Centre (JRC) (2023). Cedefop offers a regularly updated online interactive dashboard using OJA data to support skills demand monitoring and policymaking[20].

1.2 Objectives of the study

This analysis aims to demonstrate how the DigComp framework could act as a bridge between the supply and demand of digital skills by describing the type and prevalence of digital competences required in online job advertisements in the EU through the lens of DigComp, the European Digital Competence framework for citizens. Using DigComp allows to bridge the "demand side" of digital skills, as measured in OJA, with the "supply side" of education and training offer, for which DigComp is used in a majority of EU countries in formal, informal and non-formal education and training programmes[21].

The rationale for the study is driven by a need for a better understanding of digital skill demand taking a generalist approach, i.e. in order to develop the evidence base for digital skills demand in non-ICT-specialist occupations. This can provide a source of evidence for policy that complements the evidence on ICT specialisms. By using DigComp as a conceptual base, demand can be related to education and training offer. This analysis also assesses the extent to which the mapping exercise is useful to measure digital skills demand as indicated by OJA, for example by highlighting domains where digital skills demand may be insufficiently precise or explicit.

Specifically, the aims of the study are:

1. To develop and implement a methodology to map DigComp to the ESCO skills pillar.

2. To explore and describe the level of DigComp-mapped skill demand at the OJA-ESCO-skills unit level.

3. To identify areas for further consideration and research with regard to each of the three information sources (DigComp, ESCO and Skills-OVATE) to enable a stronger bridge between supply and demand.

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[20] https://www.cedefop.europa.eu/en/tools/skills-online-vacancies/
[21] EDSC feasibility study final report, forthcoming.

# 2 Digital competences and skills – Frameworks and Data

This section presents the digital competence framework (DigComp) and the data sources used in this mapping exercise: the Skills-OVATE database – which collects statistical data for online job advertisements in the EU – and the ESCO framework, which is used as the target taxonomy for occupations and skills in Skills-OVATE.

2.1.1 Overview of DigComp

Digital competence has been identified as one of the eight key competences for lifelong learning and is defined as 'the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property related questions, problem solving and critical thinking' (European Commission, Directorate-General for Education, Youth, Sport and Culture, 2019). While digital skills refer to the ability to use digital devices and technologies effectively and confidently, digital competences are broader than skills because they encompass knowledge, skills and attitudes (Cedefop, 2023). Nonetheless, these two terms are often used interchangeably.

The European Digital Competence Framework for Citizens (DigComp), now in its fourth edition (DigComp 2.2; Vuorikari et al., 2022) describes the knowledge, skills and attitudes of digital competence in five digital competence areas, which are further subdivided into 21 competences (Figure 1). The latest version of DigComp includes 259 examples of knowledge, skills and attitudes associated with each competence. These examples take into account recent and emerging developments such as artificial intelligence (AI; the Annex shows more detailed descriptions of each DigComp competence.

Figure 1: The DigComp conceptual reference model (five competence areas and 21 competences)
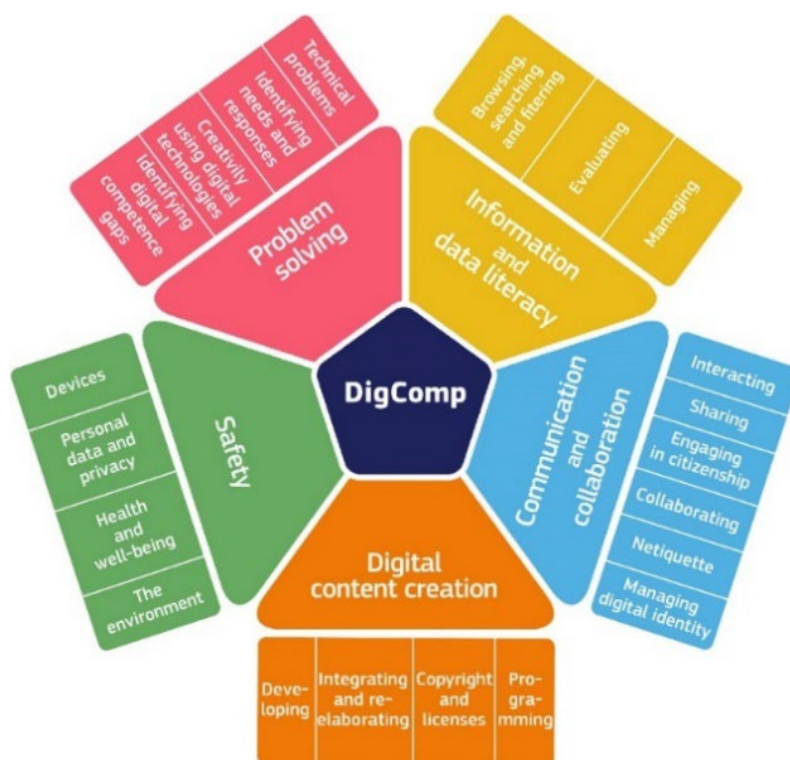
Source: European Commission, Joint Research Centre.

DigComp is used at EU level to guide policies and initiatives related to digital skills supply. For example, it forms the conceptual basis for Eurostat's Digital Skills Index (DSI 2.0, derived from the survey ICT usage in households

and by individuals), which is used to monitor levels of digital skills of citizens[22]. It also forms the basis for the work on the European Digital Skills Certificate (EDSC), under Action 9 of the Digital Education Action Plan[23]. DigComp is used in a majority of EU Member States at national and regional levels for a range of purposes including policy design and implementation[24].

2.1.2 Overview of the ESCO framework

ESCO is the European multilingual classification of Skills, Competences and Occupations. It is a European Commission project, run by Directorate General Employment, Social Affairs and Inclusion (DG EMPL). ESCO aims to provide a framework for matching labour market demand with education and training offer, and matching people to jobs, thereby enhancing EU mobility, bridging gaps between education and labour markets, and fostering collaboration among Public Employment Services[25].

ESCO is developed across three "pillars", which provide structured classifications of occupations, skills, and qualifications. In particular, it provides descriptions of 3,008 occupations and nearly 14,000 skills, linked to these occupations. Originally developed in English, it is translated into 28 EU languages.[26]. It is designed to work as a dictionary, describing, identifying, and classifying occupations and skills in a manner that is relevant for the EU labour market and education and training. Reflecting the evolving nature of the labour market, the ESCO framework is regularly updated; the most recent version (1.1) was launched in 2022 following a two-year review process[27].

The ESCO Skills pillar provides a custom structured hierarchical classification of 13,890 skills[28]. At the most aggregated (highest) level, it distinguishes between transversal and more thematic skills or knowledge in relation to job sector, and language-related knowledge and skills[29].

2.1.3 Overview of the EU Skills-OVATE database

Skills-OVATE is a database providing detailed information on the demand for different types of jobs and skills, based on online job advertisements (OJA).[30] It is jointly managed by Cedefop and Eurostat, with data collection by Lightcast. Skills-OVATE contains information based on tens of millions of OJA since 2018, from thousands of sources across the European Union (EU-27 and United Kingdom), including private job portals, public employment service portals, recruitment agencies, online newspapers and corporate websites.

The statistical data presented in Skills-OVATE is extracted from the original text of online job advertisements, using various machine-learning algorithms, and classified into relevant fields, including the date of the posting, its location, the job title, the corresponding occupation class, the salary range and type of contract offered, and the skills required. Several of these fields are coded in terms of standardised classes; most notably, occupation and skills are classified in terms of their respective ESCO pillars.

The use of standard classifications like ESCO allows for cross-country comparisons, for instance to compare the skill requirements of the same job across EU countries. Among the rich vocabulary of nearly 14,000 ESCO skills, only about 2,670 are detected in EU online job advertisements. This reflects both conceptual and methodological differences: ESCO skills can be abstract, and can provide exhaustive occupational descriptions. OJA, by contrast, are traditionally concise, and may omit skill requirements that are obvious in context.

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[22] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220330-1

[23] https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-9?

[24] Examples of use-cases can be found at https://op.europa.eu/en/publication-detail/-/publication/2b2c2207-5ca2-11e8-ab41-01aa75ed71a1/language-en, https://www.digcomphub.eu/news-events/, and https://digital-skills-jobs.europa.eu/en/inspiration

[25] Examples of use-cases can be found at https://esco.ec.europa.eu/en/about-esco/publications/publication/esco-use-cases

[26] https://esco.ec.europa.eu/en/about-esco/

[27] https://esco.ec.europa.eu/en/about-esco/what-esco/escos-continuous-improvement

[28] This is the total in version 1.0.9. https://esco.ec.europa.eu/en/classification/skill_main

[29] Further information on the Skills pillar of ESCO, including the possibility to download the data, is available on the ESCO website https://esco.ec.europa.eu/en/classification/skill_main
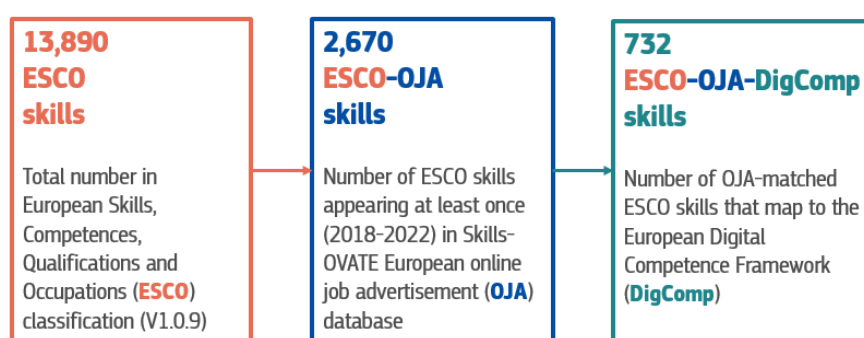
[30] https://www.cedefop.europa.eu/en/tools/skills-online-vacancies

3 Methodology and caveats

3.1 Methodology

The study involved manually mapping the skills mentioned in EU online job advertisements into the Digital Competence framework (DigComp).

The reference data includes all online job advertisement recorded in Skills-OVATE between 1/7/2018 and 30/07/2022. The numbers of OJA per year are considerable, running into the millions. These advertisements referenced 2,670 distinct skills, out of a total of 13,890 covered in ESCO. Comparing the level of detail of the ESCO skills descriptors with that of the DigComp framework made it clear that manual coding was preferable. This allowed us to leverage the authors' in-depth understanding of the DigComp framework, and also because an initial review indicated that a machine-learning classifier would be unlikely to correctly identify all relevant instances of DigComp-relevant skills. The matching and mapping process is illustrated in Figure 2.

Figure 2: Description of the matching and mapping process across ESCO, OJA and DigComp

13,890 ESCO skills

Total number in European Skills, Competences, Qualifications and Occupations (**ESCO**) classification (V1.0.9)

2,670 ESCO-OJA skills

Number of ESCO skills appearing at least once (2018-2022) in Skills-OVATE European online job advertisement (**OJA**) database

732 ESCO-OJA-DigComp skills

Number of OJA-matched ESCO skills that map to the European Digital Competence Framework (**DigComp**)

For the DigComp mapping, all 2,670 ESCO skills appearing at least once in Skills-OVATE OJA were individually reviewed and mapped to DigComp, if the ESCO skills descriptor was judged to come under one or more of the 21 DigComp competences. Commonly, a given ESCO skill descriptor contains elements that map to more than one DigComp competence (i.e. both one-to-one and one-to-many relationships exist). To keep the analysis manageable, each record (i.e., ESCO skill) has been mapped to up to four different DigComp competences. Equal weight has been given to each of the DigComp competences in analyses.

To guide the mapping, relevant information on DigComp was compiled into a single spreadsheet grouped by competence. This consisted of the 259 examples in DigComp 2.2 and the DigCompSAT 82-item bank (Clifford et al., 2020). This spreadsheet compilation was searched for key words or phrases to check and confirm the assignment of DigComp competences to ESCO skills on the basis of published examples.

DigComp does not explicitly feature specialised equipment or machinery. Therefore, ESCO skill descriptors featuring their use are regarded as outside of DigComp.

As well as the DigComp competence(s), 732 DigComp-mapped ESCO skills were categorised as:
- Has an explicit digital focus
- Does not have an explicit or exclusive digital focus (but would take place in a digital environment at least in part).

The mapping was completed by one of the authors with in-depth knowledge of DigComp with systematic checking by the other two authors. This internal validation resulted in the de-classification of just one of the 733 skills. To generate the frequencies with which DigComp-mapped skills instances appeared in OJA, the DigComp-mapped ESCO skills data was matched to the Skills-OVATE data at the level of individual advertisement and skill.

An extract of the mapping DigComp competences to ESCO skills is shown in Table 2 in the Annex, which also provides a link to the complete machine-readable mapping.

3.2 Limitations and caveats

3.2.1 ESCO-DigComp mapping

Although the DigComp mapping to ESCO has been thoroughly internally checked, it has yet to undergo an external validation. Therefore, all results reported in Section 4 should be regarded as preliminary.

Since ESCO and DigComp were originally designed for related but somewhat different purposes, the use of language or terminology is not perfectly aligned in all cases. This necessarily required some inferencing by the researchers during the mapping. Nonetheless, the internal checking and validation give reassurance of the consistency and validity of mapping.

In addition to competence (content) descriptions, DigComp contains descriptions of proficiency levels (basic, intermediate, advanced and highly specialised). Based on the content of the ESCO skills descriptors it was not possible to assign a proficiency level in the mapping exercise.

3.2.2 ESCO skills classification

The ESCO classification was designed for various applications, and using it to code skills from online job advertisements is a more recent use-case. There are obvious practical advantages to representing skills in common standard across domains: from public employment services, to employment surveys, to online job advertisements, but this also implies a trade-off in terms of the adequacy of the classification in specific applications. To date, only a minority of ESCO skills are detected in OJA, and possibly not all skills mentioned in the original text of advertisements feature in ESCO. Over the past few years, the ESCO Secretariat, which manages the development of the classification, has been testing and implementing data-driven approaches to update the classification, including efforts to ensure that emerging skills are represented. It does so by collecting data from various sources, including online job advertisements themselves.

Language variety is another challenge of using ESCO as a reference classification for EU OJA. ESCO itself was originally developed in English, and subsequently translated into each official EU language. Given the challenges of translation, the ESCO skill description in languages other than English may not always correspond exactly with the native vocabulary used in online job advertisements. As a result, Skills-OVATE detects a variable number of skills for each advertisement, depending on the language and country, with English-language OJA featuring the most. Both ESCO and Skills-OVATE are continuously improved to ensure that OJA in every EU language are fully processed.

3.2.3 Online job advertisements

While the usage of OJA data for labour market intelligence to support labour market and education and training policies is expanding (Napierala and Kvetan, 2023), it presents a series of technical challenges that could result in a biased description of the labour market (OECD (2022), Beręsewicz and Pater (2021), Cedefop, European Commission, ETF, ILO, OECD, UNESCO (2021), Fernández-Macías and Sostero (2024) and Sostero and Fernández-Macías (2021)). The unstructured information provided often suffers from statistical, selection and conceptual biases (e.g., they are more skewed toward employers seeking more highly skilled professions or those more exposed to the Internet). Consequently, in low-income countries, higher informal employment and a less-developed digital infrastructure means online recruitment covers only a small part of the job market, mainly formal and "white-collar" jobs. In English-speaking countries this data is already being widely used for labour market analysis – and is beginning to inform skills policy. In Europe, the diversity of languages creates an additional technical difficulty for comparative analysis.

OJA tend to require more effort to prepare for analysis than data collected using conventional approaches. They are scattered across different websites and portals, where they are presented in different formats. Retrieving, extracting and classifying this text into structured, meaningful information is a complex endeavour, which requires a mix of automated algorithms with human supervision and expert domain knowledge. This process inevitably entails some degree of human judgement and arbitrariness as well as errors resulting from the usage of algorithms.

For these reasons, exploiting the complementarities of big data and other sources of skills intelligence is key to generate statistically robust and policy-relevant evidence. In other words, OJA should be considered among multiple sources of evidence for policy.

> Given the limitations above, it is recommended to use the DigComp-ESCO-OJA mapping for broad-level analysis, and to avoid making inferences at a more granular level, for example for specific occupations.

4 Results

This section presents the results of the DigComp mapping initially to ESCO, and subsequently results of analyses which matched the skills to the Skills-OVATE online job advertisements.

4.1 Coverage of DigComp in ESCO skills

Mapping of DigComp to ESCO resulted in the identification of 732 of the 2,670 OJA records (27%) as containing an ESCO skills description which came under one or more of the 21 DigComp competences. On average, there are 1.55 DigComp competences per skill: 343 ESCO skills (47%) were mapped to one competence; 340 (46%) to two competences, 45 (6%) to three, and just 4 (<1%) to four.

The most commonly-mapped DigComp competence area is <u>information and data literacy</u> (54.5%), followed by <u>digital content creation</u> (25.6%), then <u>communication and collaboration</u> (12.8%). Much less frequent are ESCO skills being mapped to the DigComp competence areas of <u>problem solving</u> (3.8%) or <u>safety</u> (3.3%) (Figure 3).

Figure 3: Distribution of the ESCO skills across DigComp competence areas
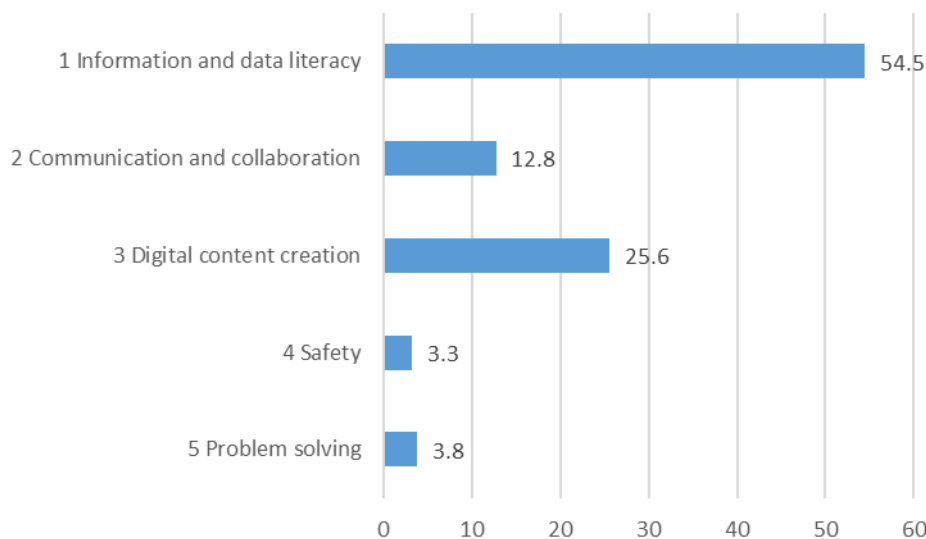
Note: Figure 3 shows 27% of 2,670 ESCO skills which have been mapped to one or more OJA *and* DigComp.

Figure 4 shows the distribution of ESCO skills across the 21 DigComp competence areas. As already suggested in Figure 3, <u>information and data literacy</u> receives the highest emphasis in the mapping, and within this area, competence 1.3, *managing data, information and digital content* appears more often in ESCO than the others. Under the DigComp competence <u>communication and collaboration</u>, *interacting through digital technologies* is the most frequent, and competences 2.5 (*Netiquette*) and 2.6 (*managing digital identity*) do not feature at all, while *engaging citizenship* is barely present. Under <u>digital content creation</u>, *developing digital content* and *programming* feature most strongly, while *elaborating and re-integrating digital content* features somewhat less, and *copyright and licences* practically do not feature. Frequencies of competences under the DigComp competence area <u>safety</u> feature much less often, and 4.3 (*protecting health and wellbeing*) and 4.4 (*protecting the environment*) do not feature at all. Similarly, competences under the DigComp competence area of <u>problem solving</u> are infrequent, and *identifying digital competence gaps* practically does not feature.

Arguably, many of the ESCO skills in which DigComp competences feature prominently contain DigComp competences implicitly. For example, *collaborating through digital technologies* would logically involve elements of *Netiquette* and *managing digital identity,* but the wording of the ESCO skills does not allow this inference to be reliably made.

Conversely, recall that 53% of ESCO skills mapped to more than one DigComp competence and many of these may require elements of <u>problem solving if considered in everyday working contexts</u>. Nonetheless, the almost

complete absence of *identifying digital competence gaps*[31] is noteworthy, given the pace of change of the digital transformation.

Also, the low emphasis on *protecting devices* and on *protecting data and personal privacy* contrasts to the situation in many jobs where personal data is handled and processed, as well as with concerns about cybersecurity risks, which rely in part on individuals' competences to mitigate them.

Finally, lack of inclusion skills in relation to *managing digital wellbeing* or *protecting the environment* could indicate gaps in the specifications of ESCO skills/OJA, and/or to the fact that digital wellbeing and environmental sustainability may be seen from employers' perspective as matters for organisational policies (e.g. human resources, sustainability) rather than OJA content.

Figure 4: Distribution of the ESCO skills across DigComp competences
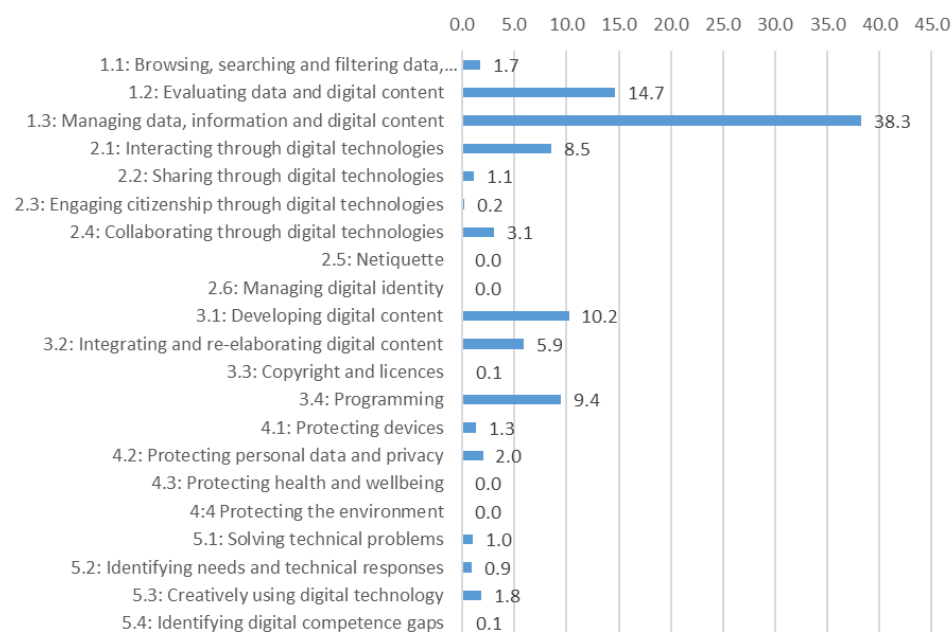
Note: Figure 4 shows 27% of 2,670 ESCO skills which have been mapped to one or more OJA *and* DigComp.

4.2   Digital competence levels in EU online job ads

4.2.1   Overall

Figure 5 shows the distribution of OJA skills by DigComp competence area. The most frequently-identified DigComp competence area is information and data literacy (just over 40% of OJA), followed by digital content creation (32%) and communication and collaboration (31%). In contrast, the DigComp competence area of problem solving appeared in just 13% of OJA, and safety in just 1%.

It can be argued that elements of information and data literacy, communication and collaboration, and digital content creation are combined in jobs for problem solving, albeit that this is not explicitly described in OJA. However, as noted previously, the almost non-existence of safety competences in OJA may indicate a need for better specification of these elements in job advertisements.

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[31] To understand where one's own digital competence needs to be improved or updated. To be able to support others with their digital competence development. To seek opportunities for self-development and to keep up-to-date with the digital evolution.

As well as varying across competence area, there is variation in the extent to which DigComp competence areas have an **explicit or implicit digital focus** (i.e. explicitly mentioning digital environment, not explicitly mentioning digital environment but logically requiring some element of digital environment for execution). For example, of the OJA skills instances featuring digital content creation, a little over two-thirds had an explicit digital focus. This contrasts to the results for communication and collaboration, where a little under one in four skills instances had an explicit digital focus. Again, this has some implications for OJA specifications, whereby information to applicants could be clearer if the digital and non-digital features of these transversal skills were explicitly described.

Figure 5: Share of EU online job ads requiring DigComp-related skills, by DigComp competence area and explicit/implicit digital focus (average across EU plus UK in 2022)
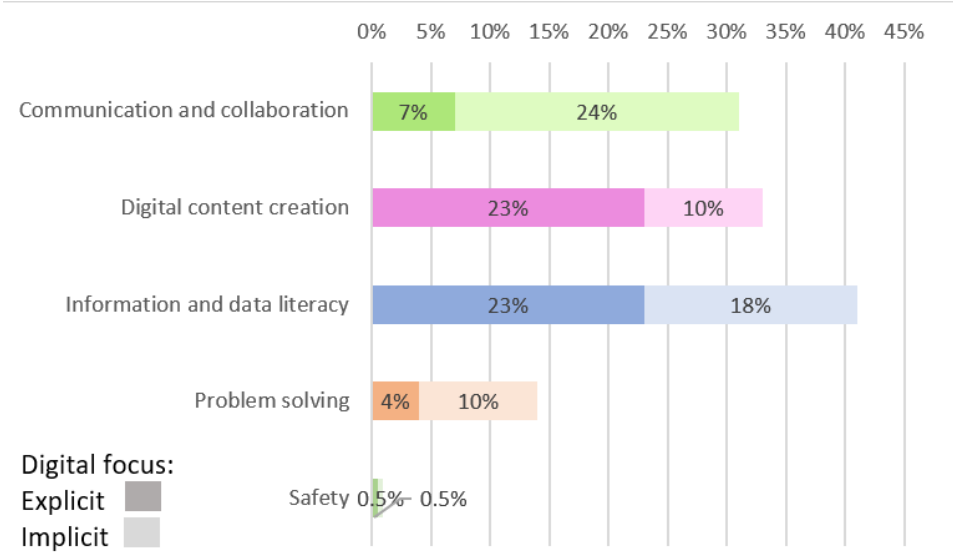
4.2.2 By occupation level (1-digit ISCO)

Figure 6 shows the results by occupation level (i.e. the first level of the ESCO classification). The results show that DigComp-classified digital skills are in greatest demand in occupations in the Managers; Professionals; Technicians and associate professionals; and Clerical and support workers groups. The demand is lower among Service and sales workers; Skilled agricultural, forestry and fishery workers; Craft and related trades workers; Plant and machine operators and assemblers; and Elementary occupations. Communication and collaboration, digital content creation, and information and data literacy are particularly high for Managers and Professionals. Among Technicians and associate professionals and Clerical Support workers, information and data literacy features the most strongly.

Figure 6: Share of EU online job ads requiring DigComp-related skills, by DigComp competence area and explicit/implicit digital focus and occupation (1-digit ISCO group)
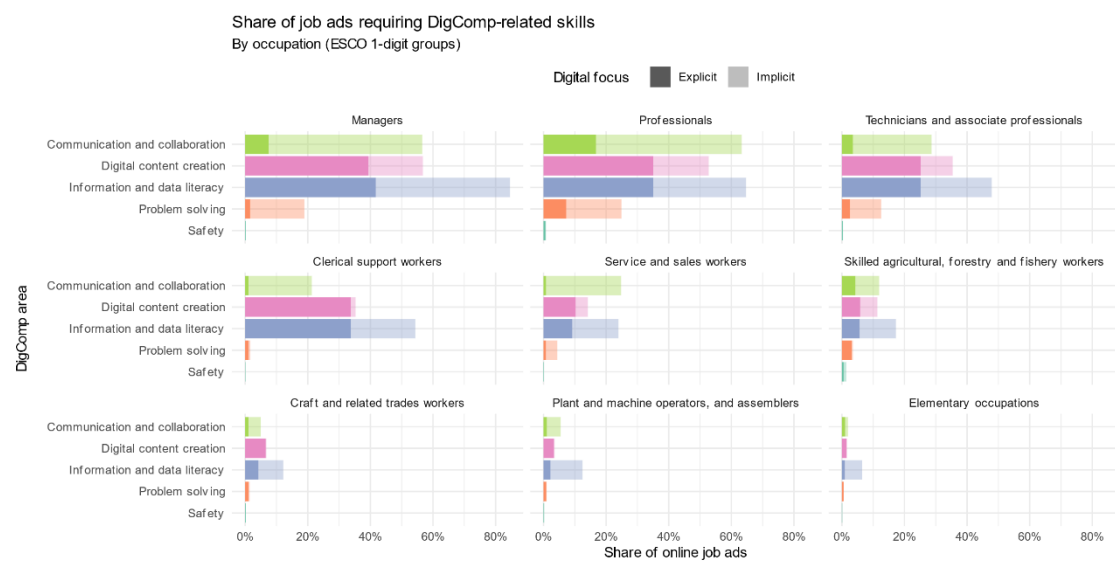
4.2.3 By country

Figure 7 shows how these results vary across countries. Notwithstanding the fact that higher percentages generally appear in English-speaking countries (Ireland, Malta, UK; see Section 3.2.2), there is nonetheless some interesting variation across countries.

For example, communication and collaboration tends to be lower in Estonia, Finland, Hungary, Lithuania, Latvia and Slovenia. Digital content creation skills are relatively high in Cyprus. Information and data literacy is quite high in Cyprus, Czechia, Greece, France, Luxembourg and Portugal. Problem solving is markedly higher in Austria than in other countries, while safety is emphasised in Bulgaria more than other countries.

Figure 7: Share of EU online job ads requiring DigComp-related skills, by DigComp competence area and explicit/implicit digital focus and country, 2022
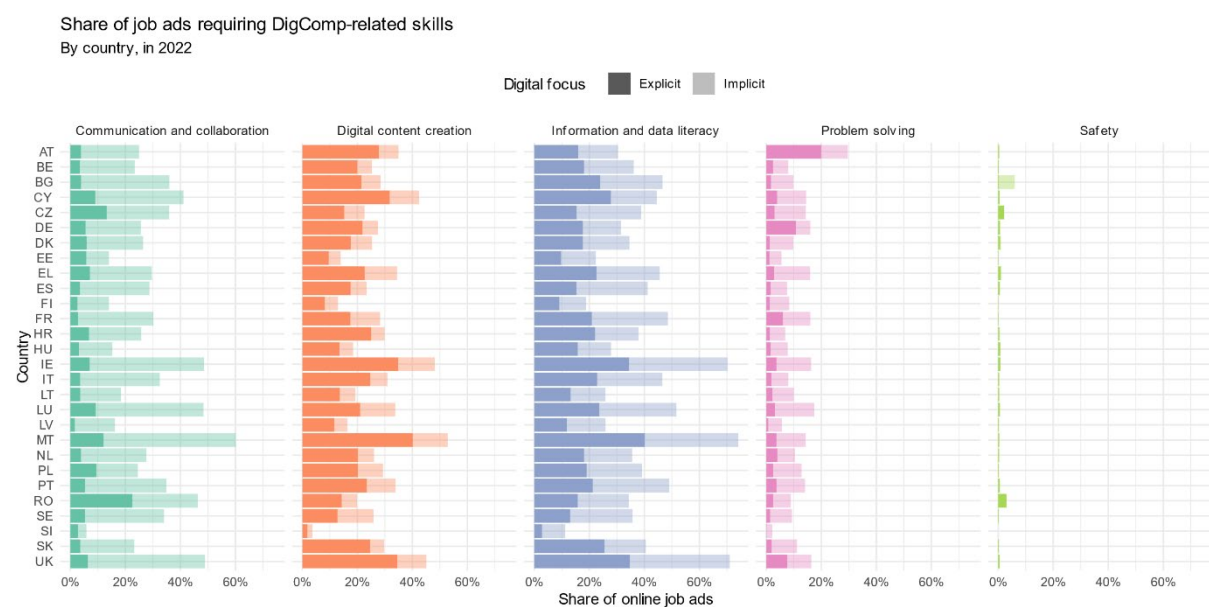
5 Conclusions

Using a new mapping technique and the latest version of DigComp which provides over 250 concrete examples of digital competences, we have demonstrated that Digital skills, as defined under DigComp, are highly represented in ESCO classification system, and in the European online job advertisement (OJA) database, Skills-OVATE. It should be emphasised that the study is exploratory and that the initial mapping will need to undergo further validation. The mapping is published as an Annex to this technical report to invite further research on the topic (see the Annex).

Nonetheless, findings confirm the high demand of non-ICT-specialist skills in the labour force (at least from the perspective of OJA) and the **exploratory approach, could possibly represent a methodology for monitoring and responding to non-specialist digital skills needs.**

The analysis provides emerging empirical evidence in support of policies which aim to develop digital skills among all. Indeed, evidence from data on supply confirms that in 2021, across the EU, 46% of the adult population has below basic digital skills[32], and 13% of EU workers reported being digitally under-skilled to a great extent (and 39% to a moderate extent) (Cedefop, 2022).

An examination of the distribution of DigComp competence areas and competences across ESCO skills and OJA confirms that these are not at all evenly represented. This indicates that **digital skills demand from OJA is concentrated in information and data literacy; digital content creation; and communication and collaboration, while almost absent for safety** (which encompasses protection of devices and personal data and privacy, digital wellbeing and environmental sustainability).

The uneven coverage of DigComp competences has implications for all three sources of information used. The very **low emphasis given to safety-related competences** in the OJA implies a need to raise awareness of these competences and to further explore their relevance to on-the-job skills. Regarding **OJA (Skills-OVATE)**, findings suggest that there would be merit in **more precise specification** of whether execution of competences is required in **digital or non-digital environments**. For **ESCO**, it must be noted that the DigComp **mapping is partial (i.e. based on the subset that appears in Skills-OVATE)** and that a complete mapping of DigComp onto the 14,000 ESCO skills would enable a more complete picture to be developed. The uneven coverage competences also confirm a need to triangulate OJA digital skills demand analysis with other sources.

Development work on DigComp by the JRC envisaged during 2024-2025 foresees the production of a set of **indicative learning outcomes** on the basis of a synthesis of those which already exist through national and regional initiatives and others that might be related to new emerging technologies. **Linking** these learning outcomes **in the future to ESCO** could help to strengthen the bridge between supply and demand of digital skills. However, the manual mapping of DigComp to ESCO skills is labour intensive, so to be sustainable, a combination of automated and manual approaches would need to be developed. The European Commission project to link learning outcomes with ESCO skills via a linking tool, currently under development[33], offers considerable potential in this regard.

It has already been noted (e.g. Centeno et al., 2022) that an **analysis of digital skills supply and demand is hampered by differences in the definitions, methods and measures used** in available data. This underlines the need for clarity in reporting on such analyses to avoid misinterpretation and also suggests a need to reflect on how adaptations to measurements could **support alignment and complementarity**. For example, the second European Skills and Jobs Survey (ESJS2, 2021) provides in-depth information on the digital environments of workers, participation in education and training, and perceived digital skills mismatch. A more granular measure of digital skills mismatch which is based on the DigComp competence areas in a future iteration of the survey would be one possible way to align measures using a common overarching framework.

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[32] https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231215-3
[33] https://esco.ec.europa.eu/en/about-esco/escopedia/escopedia/linking-learning-outcomes-qualifications-esco-skills

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List of abbreviations and definitions

AI — Artificial Intelligence, which refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals (https://digital-strategy.ec.europa.eu/en/library/definition-artificial-intelligence-main-capabilities-and-scientific-disciplines)

Cedefop — European Centre for the Development of Vocational Training (https://www.cedefop.europa.eu/en)

DigComp — European Digital Competence Framework for Citizens (https://joint-research-centre.ec.europa.eu/digcomp_en)

DSI — Digital Skills Indicator, currently version 2.0, based on DigComp and used to monitor the level of digital skills in the population. Data are gathered via the EU survey on the use of Information and Communication Technologies (ICT) in households and by individuals (https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm)

EDSC — The European Digital Skills Certificate is a study conducted under Action 9 of the European Digital Education Action Plan. It aims to enhance the transparency and mutual recognition of digital skills certifications and is based on DigComp (https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-9?)

ESCO — European Skills, Competences and Occupations (https://esco.ec.europa.eu/en)

ETF — European Training Foundation, an agency of the European Commission which supports reform of education, training and labour market systems in partner countries (https://www.etf.europa.eu/en/about)

Eurostat — Official source of statistics of the EU (https://ec.europa.eu/eurostat)

ILO — A tripartite agency of the UN which develops policies, programmes and standards to promote good working conditions and practices (https://www.ilo.org/global/about-the-ilo/lang--en/index.htm)

JRC — Joint Research Centre of the European Commission (https://joint-research-centre.ec.europa.eu/index_en)

OECD — Organisation for Economic Co-operation and Development is an international organisation whose goal is to shape policies which foster prosperity, equality, opportunity and wellbeing (https://www.oecd.org/about/)

OJA — Online Job Advertisement(s)

Skills-OVATE — Skills Online Vacancy Analysis Tool for Europe, managed by Cedefop and Eurostat (https://www.cedefop.europa.eu/en/projects/skills-online-job-advertisements)

UNESCO — United Nations Educational, Scientific and Cultural Organisation has as its main priorities for the achievement of the Sustainable Development Goals and the improvement of the human condition (https://www.unesco.org/en)

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Annex

Table 1: Detailed competence descriptions of DigComp

Competence Area	Competence	Competence description
Information and data literacy	1.1 Browsing, searching and filtering data, information and digital content	*To articulate information needs, to search for data, information and content in digital environments, to access them and to navigate between them. To create and update personal search strategies.*
	1.2 Evaluating data, information and digital content	*To analyse, compare and critically evaluate the credibility and reliability of sources of data, information and digital content. To analyse, interpret and critically evaluate the data, information and digital content.*
	1.3 Managing data, information and digital content	*To organise, store and retrieve data, information and content in digital environments. To organise and process them in a structured environment.*
Communication and collaboration	2.1 Interacting through digital technologies	*To interact through a variety of digital technologies and to understand appropriate digital communication means for a given context.*
	2.2 Sharing through digital technologies	*To share data, information and digital content with others through appropriate digital technologies. To act as an intermediary, to know about referencing and attribution practices.*
	2.3 Engaging citizenship through digital technologies	*To participate in society through the use of public and private digital services. To seek opportunities for self-empowerment and for participatory citizenship through appropriate digital technologies.*
	2.4 Collaborating through digital technologies	*To use digital tools and technologies for collaborative processes, and for co-construction and co-creation of resources and knowledge.*
	2.5 Netiquette	*To be aware of behavioural norms and know-how while using digital technologies and interacting in digital environments. To adapt communication strategies to the specific audience and to be aware of cultural and generational diversity in digital environments.*
	2.6 Managing digital identity	*To create and manage one or multiple digital identities, to be able to protect one's own reputation, to deal with the data that one produces through several digital tools, environments and services.*
Digital content creation	3.1 Developing digital content	*To create and edit digital content in different formats, to express oneself through digital means.*
	3.2 Integrating and re-elaborating digital content	*To modify, refine, improve and integrate information and content into an existing body of knowledge to create new, original and relevant content and knowledge.*
	3.3 Copyright and licences	*To understand how copyright and licences apply to data, information and digital content.*
	3.4 Programming and functions	*To plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a specific task.*
Safety	4.1 Protecting devices	*To protect devices and digital content, and to understand risks and threats in digital environments. To know about safety and security measures and to have due regard to reliability and privacy.*
	4.2 Protecting personal data and privacy	*To protect personal data and privacy in digital environments. To understand how to use and share personally identifiable information while being able to protect oneself and others from damages. To understand that digital services use a "Privacy policy" to inform how personal data is used.*
	4.3 Protecting health and well-being	*To be able to avoid health-risks and threats to physical and psychological well-being while using digital technologies. To be able to protect oneself and others from possible dangers in digital environments (e.g. cyber bullying). To be aware of digital technologies for social well-being and social inclusion.*
	4.4 Protecting the environment	*To be aware of the environmental impact of digital technologies and their use.*
Problem solving	5.1 Solving technical problems	*To identify technical problems when operating devices and using digital environments, and to solve them (from trouble-shooting to solving more complex problems).*
	5.2 Identifying needs and technological responses	*To assess needs and to identify, evaluate, select and use digital tools and possible technological responses to solve them. To adjust and customise digital environments to personal needs (e.g. accessibility).*
	5.3 Creatively using digital technologies	*To use digital tools and technologies to create knowledge and to innovate processes and products. To engage individually and collectively in cognitive processing to understand and resolve conceptual problems and problem situations in digital environments.*
	5.4 Identifying digital competence gaps	*To understand where one's own digital competence needs to be improved or updated. To be able to support others with their digital competence development. To seek opportunities for self-development and to keep up-to-date with the digital evolution.*

Table 2 below shows a few illustrative entries of the ESCO-DigComp mapping.

The full machine-readable mapping is available at https://zenodo.org/doi/10.5281/zenodo.10674444

Table 2: Extract of ESCO-DigComp mapping

ESCO						DigComp			
ESCO skill	ESCO skill description	ESCO skill hierarchy Level 0	ESCO skill hierarchy Level 1	ESCO skill hierarchy Level 2	ESCO skill hierarchy Level 3	DigComp (primary class)	DigComp (secondary class)	DigComp (tertiary class)	Explicit digital focus
customer service	Processes and principles related to the customer, client, service user and to personal services; these may include procedures to evaluate customer's or service user's satisfaction.	knowledge	business, administration and law	business and administration	work skills	1.3: Managing data, information and digital content	2.1: Interacting through digital technologies		No
project management	Process of supervising the correct functioning of systems, buildings or plants during the final stages before deployment.	knowledge	business, administration and law	business and administration	management and administration	1.3: Managing data, information and digital content	1.2: Evaluating data and digital content		Yes
business ICT systems	The software packages, hardware devices and new technologies used in supporting business processes such as enterprise resource planning (ERP), customer relationship management (CRM), mobile devices and network solutions.	knowledge	information and communication technologies (icts)	information and communication technologies (icts)	computer use	1.3: Managing data, information and digital content	2.4: Collaborating through digital technologies		Yes
manage budgets	Plan, monitor and report on the budget.	skills	management skills	allocating and controlling resources	managing budgets or finances	1.3: Managing data, information and digital content	1.2: Evaluating data and digital content		No
report analysis results	Produce research documents or give presentations to report the results of a conducted research and analysis project, indicating the analysis procedures and methods which led to the results, as well as potential interpretations of the results.	skills	information skills	documenting and recording information	documenting technical designs, procedures, problems or activities	1.3: Managing data, information and digital content	3.1: Developing digital content	2.1: Interacting through digital technologies	No
brainstorm ideas	Pitch your ideas and concepts to fellow members of the creative team in order to come up with alternatives, solutions and better versions.	skills	communication, collaboration and creativity	liaising and networking	coordinating activities with others	2.4: Collaborating through digital technologies			No
computer programming	The techniques and principles of software development, such as analysis, algorithms, coding, testing and compiling of programming paradigms (e.g. object oriented programming, functional programming) and of programming languages.	knowledge	information and communication technologies (icts)	information and communication technologies (icts)	software and applications development and analysis	3.4: Programming	3.1: Developing digital content		Yes

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