

European Software
Skills Alliance.

A Software Skills Strategy for Europe

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About ESSA

The European Software Skills Alliance (ESSA) is a four-year transnational project funded under the EU’s Erasmus+ programme. It ensures the skills needs of the rapidly evolving Software sector can be met — today and tomorrow.

ESSA provides current and future software professionals, learning providers and organisations with software needs with the educational and training instruments they need to meet the demand for software skills in Europe.

ESSA will develop a European Software Skills Strategy and learning programmes for Europe. It will address skill mismatches and shortages by analysing the sector in depth and delivering future-proof curricula and mobility solutions; tailored to the European software sector’s reality and needs.

Project partners

The ESSA consortium is led by DIGITALEUROPE. It is composed of academic and non-academic partners from the education, training, and software sectors.

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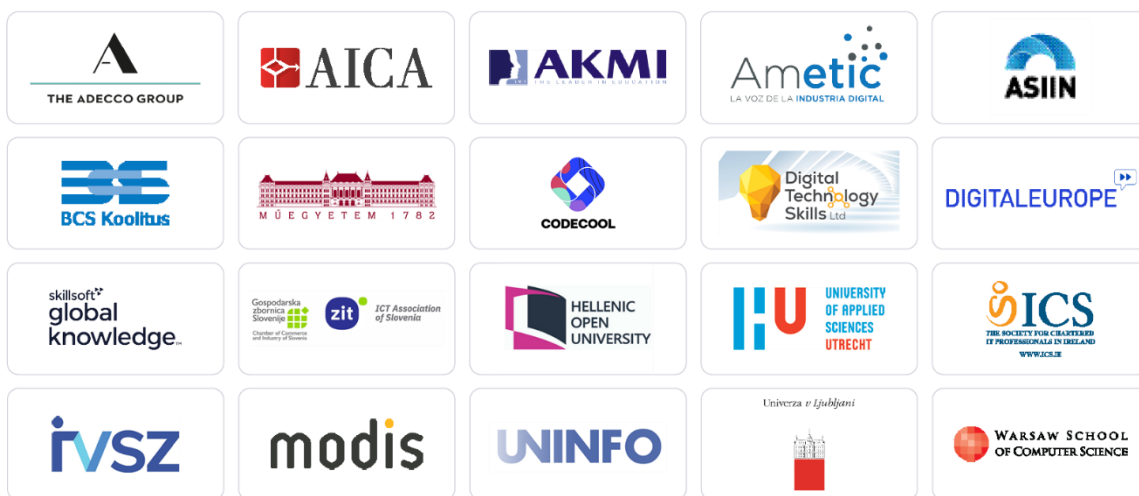


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List of abbreviations and acronyms

Abbreviation	Term
ACM	Association for Computing Machinery
AI	Artificial Intelligence
CEDEFOP	Centre Européen pour le Développement de la Formation Professionnelle
CEN	Comité Européen de Normalisation
CEN/CWA 16458-1	CEN Workshop Agreement 16458-1 European ICT Professionals Role Profiles – Part 1: 30 ICT Profiles
CNECT	Directorate General for Communications Networks, Content and Technology
CSOs	Civil Society Organisations
CULT	European Parliament's Committee on Culture and Education
DCC	Digital Competence Centre
DG EMPL	Directorate General for Employment
DG EAC	Directorate General for Education and Culture
e-CF, EN 16234-1	European e-Competence Framework, European Norm 16234 - Part 1: Framework
ECVET	European Credit system for Vocational Education and Training
EQF	European Qualifications Framework
ESCO	European Skills, Competences, Qualifications and Occupations
ESSA	European Software Skills Alliance
EU	European Union
DG GROW	Directorate General for the Internal Market, Industry, Entrepreneurship & SMEs
ICT	Information and Communication Technology
IoT	Internet of Things
IRTE	European Parliament's Committee on Industry, Research and Energy
IT	Information Technology
LOs	Learning Outcomes
PLOs	Programme Learning Outcomes
SME	Small and Medium-sized Enterprise
VET	Vocational Education and Training
VR/AR	Virtual reality/ Augmented reality
WEF	World Economic Forum
WP	Work Package

1 Executive summary

Developments in digital transformation and the related requirements to be met by organisations are resulting in a high demand for ICT professionals, especially for those involved in the development, maintenance and operation of software. This swiftly rising demand has not only led to a shortage of software professionals that can fulfil this demand, but also to a shortage in the necessary skills to keep up with these changes. This growing skills gap is an area of great concern on national levels and on European level. Not least because Europe is also lagging behind globally in this respect.

This Strategy document presents an integrated and structured approach with clear steps, mechanisms, and tools to overcome this skills gap in Europe.

The proposed actions and recommendations in this Strategy are guided by the following vision and mission for the software sector in Europe:

VISION

A thriving, inclusive and attractive software services sector with a sufficient and balanced supply of skilled software professionals across Europe for now and the future.

MISSION

To promote and support the equipment of software services professionals with the right competences and skills to meet the continuously changing market, technological, social and environmental demands.

The mission states how the vision can be realised and serves to define meaningful actions for the present and future. To achieve this mission, it is necessary that:

- (1)** Software professionals must possess the right competences and skills,
- (2)** Training and education providers need to include these skills in their programmes and enable skilling, reskilling and upskilling,
- (3)** There is a strategic cooperation among an ever-growing group of stakeholders that promotes and further consolidates the actions to achieve a sustainable development of the software services sector.

Therefore, this Strategy (1) considers skills and roles needed now and in the future, (2) provides tools and recommendations for education and training and (3) supports the establishment of a software services network of stakeholders. This leads to three strategic pillars this Strategy is built on.

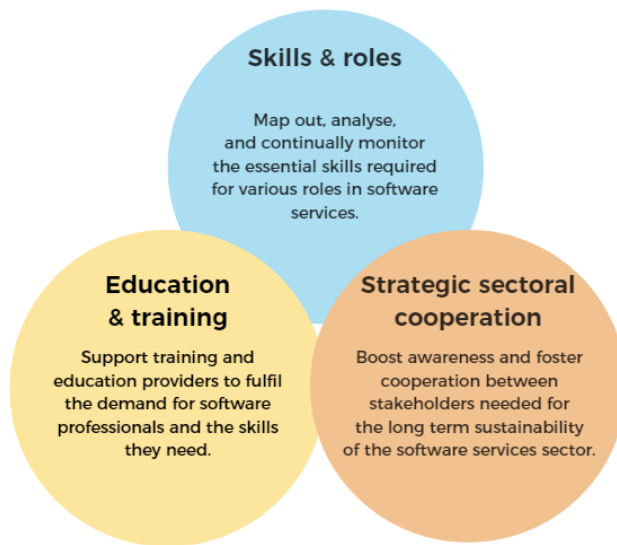


Figure 1. A Software Skills Strategy for Europe: Strategic pillars

These three pillars are translated into six strategic objectives that define the concrete goals to be realised in the short and longer term. The strategic objectives are linked to concrete actions.

Strategic objectives	1. Monitor and analyse skills needs	2. Monitor and analyse market-oriented software roles	3. Design and develop harmonised curricula	4. Validate learning outcomes	5. Boost awareness	6. Foster cooperation
Operational objectives	<p>Identify urgent skills needs for software professionals</p> <p>Identify emerging skills needs for software professionals</p>	<p>Monitor developments in existing software related roles</p> <p>Identify emerging software related roles</p>	<p>Develop and maintain European educational profiles for software roles</p> <p>Design curricula and implement learning programmes tailored for specific contexts</p> <p>Develop and maintain learning materials</p>	<p>Design and implement a certification scheme for software professionals</p> <p>Design and implement a quality label for learning providers</p>	<p>Develop and implement a communication strategy</p> <p>Build and maintain a software online community</p>	<p>Build and foster a software sector alliance</p> <p>Connect to European standards and initiatives</p> <p>Develop and implement a European software sector mobility programme</p>

Figure 2. A Software Skills Strategy for Europe: Strategic objectives

SKILLS AND ROLES

Strategic objective 1. Monitor and analyse skills needs. The first strategic objective focuses on distinguishing the right skills for software professionals. To identify the urgent and emerging skills needs for software professionals, research was conducted using different data collection techniques and different target groups (see ESSA Needs Analysis). A key finding is that the skills needed in software roles and jobs are certainly not limited to **hard skills**, like programming, but include also broader **profession-related skills**, like project management and **soft skills**, like communication and teamwork. These skills are found to be highly relevant to all the roles that software professionals fulfil. This finding is confirmed by a **strategy review process**, an iterative monitoring cycle focused on the demand for skills, roles and education held on a yearly basis. An important element of this process is the involvement of experts by means of expert groups, organised at national levels and at European level.

Strategic objective 2. Monitor and analyse market-oriented software roles. Besides skills, also the roles for which software professionals are trained and educated must meet market demands. To define relevant software roles, the European framework of ICT professional role profiles was used (CWA 16458) and mapped against roles listed in the ESCO classification. Five of these profiles were selected that could be classified as software professional in the context of this Strategy: **developer, DevOps expert, solution designer, test specialist, and technical (software) specialist**. These five selected role profiles were expanded with a set of broader profession-related and soft skills besides key hard skills, because the research showed an urgent need for software professionals that possess the skills to work together with other disciplines, hence **T-shaped and π -shaped professionals**.

EDUCATION AND TRAINING

Strategic objective 3. Design and develop harmonised curricula. The competences, skills, and knowledge required to succeed in a software professional role are translated into measurable learning outcomes. A set of nine **educational profiles** was developed to cover the five software roles at different qualification levels — ranging from EQF 4/5 to EQF 7 and aligned with the e-CF, the European standard that describes competences for ICT professionals at different levels. These profiles can be used to create flexible and modular learning programmes that enable individualised pathways and recognition of earlier acquired skills and competences. They also facilitate the comparison of curricula and learning programmes between different institutes and between countries, enhancing the mobility of students, learners and professionals.

Strategic objective 4. Validate learning outcomes. It is important that learning is validated to establish whether somebody is an up-to-date software professional and that software professionals can showcase their competences and skills. Assessments are the way to validate whether somebody achieved a learning outcome. An independent system of vendor-neutral assessment of learning outcomes should be created. Two actions are needed: Firstly, the design of a **certification framework** for skills of software professionals, based on the principles of micro credentialling and making use of digital badges and

secondly, a **quality label** for learning providers ensuring that their assessments, education and training are of good quality.

STRATEGIC SECTORAL COOPERATION

Strategic objective 5. Boost awareness. The strategy's success hinges on effectively utilizing communication tools to foster awareness and engagement. This involves two key strategic actions. Firstly, creating an engaging **communication plan** to activate key stakeholders and increase societal awareness about the need for software skills and solutions to address this gap. Secondly, establishing an **online Software Skills Community** will serve as a dynamic platform for stakeholders to share information, resources, and best practices and could be a catalyst for innovation in the software skills domain.

Strategic objective 6. Foster cooperation. The sixth strategic objective is to establish and nurture long-term cooperation between stakeholders, which is imperative for the continuous development of relevant and market-oriented learning programmes and learning innovations. Core to that objective is the creation of a **sector alliance** as a formal hub for exchanging ideas and strategies, hosting regular meetings and events for stakeholder engagement, and collaborating with related initiatives. Additionally, the strategy involves aligning learning programmes with **European standards** to create a common language and European-wide recognition of learning outcomes and certifications. Thirdly, cooperation is fostered through a **mobility programme**, whereby students and educators move across different countries.

2 Introduction

Skills and digital are both focal points in current EU policy. The European Commission wants to address the digital skills gap and promote projects and strategies to improve digital skills levels in Europe. But it is not just about general digital skills for all European citizens.

Europe also faces a shortage of ICT experts who can develop advanced technologies for the benefit of all citizens and more than 70% of companies say the lack of staff with adequate digital skills is a barrier to investment¹. The ICT sector is growing fast and so does the demand for a properly skilled ICT workforce. This creates considerable labour market challenges, often more popularly referred to as a skills gap.

The aim of this strategy is to formulate a clear and well-structured approach with actions to close this software skills gap in Europe and to ensure the skills needs of the rapidly evolving software sector can be met.

The strategic approach proposed in this report relies on three pillars: analysing and monitoring the right skills for software professionals, supporting the provision of training and education and creating strategic collaboration between key stakeholders.

Each year, a strategy review process takes place. The main objective of this process is to assess whether the strategy is still up to date or needs to be adjusted by collecting data on core aspects of the strategy, against which the strategy is benchmarked. The yearly review process consists of two consecutive rounds of data collection, first at the national level and secondly at European level. Both rounds involve the collecting of secondary data and primary data, the latter by means of expert groups. This version of the strategy is the result of the second iteration and incorporates the results of the first and second review processes, held in 2022 and 2023, respectively.

Because this document provides an integrated approach that addresses the multi-sectoral problem of a growing skills gap of software professionals, it is relevant to many different stakeholders in a variety of ways. The document informs policy makers and organisations such as social partners, chambers, and umbrella organisations about the concrete actions that can be undertaken to address the software skills gap. It may influence their policies and actions and serve as a source of inspiration for their initiatives. The report is also relevant to the many organisations that have software development and operations needs as well as to education and training providers. To them the document has an informative function but can also serve as inspiration in pointing out concrete actions and possibilities.

¹ European Commission. Digital Skills and Jobs. <https://digital-strategy.ec.europa.eu/en/policies/digital-skills-and-jobs>

2.1 Roadmap to the report

The report begins with a brief outline of the **state of play** in the software sector in chapter 2. The main trends and issues at play in relation to the ICT workforce are explained.

This is followed by the **vision and mission** statement in chapter 3. The vision is formulated as an ambitious shared ideal picture of the future of the software sector. The mission indicates what needs to be focused on immediately to take the first steps towards achieving the vision.

Chapter 4 translates the main elements from the mission into **three strategic pillars**, focusing on skills and roles, education and training and strategic sectoral cooperation. Besides these pillars, also the **scope** of the strategy is described, in terms of software services, skills, competences and roles, education and training and stakeholders.

The strategic pillars are translated into **six strategic objectives** with concrete actions. An overview of the relevant actions is presented in chapter 5.

The chapters that follow are the core of the report and describe these actions in more detail. Chapter 6 focuses on actions related to **skills and roles**, chapter 7 describes actions related to **education and training** and in chapter 8 actions that support **strategic sectoral cooperation** are highlighted.

3 State of play

A thriving technology sector is indispensable for Europe's future, not only in terms of economic growth and innovation but also for its strategic autonomy and resilience.² However, the European technology sector is falling behind from an international perspective, and the gap is increasing, prompting commentators to talk about "Europe's technology gap."³ At the same time, there is a digital divide in Europe, where some regions fare significantly worse than others in the digital transformation.⁴

An underlying structural problem contributing to this situation is Europe's lack of ICT skills. Even if the number of ICT specialists has steadily risen, increasing 57.8 % from 2012 to 2022,⁵ there is a shortage of millions of ICT specialists in Europe. In fact, 9.5% of European Union businesses reported in 2022 that they had either recruited or sought to hire ICT specialists in the previous year, and 62.8% of these enterprises encountered difficulties in successfully filling these job openings.⁶

The largest group of ICT specialists is those who develop and test the software underlying digital services and products.⁷ As cloud computing, AI, big data, and e-commerce become increasingly important to organisations, people with expertise in software development will become even more precious in the labour market. The World Economic Forum⁸ pointed out in their Future of Jobs report that software developers are among the most needed professions in Europe.

An additional key finding from the Future of Jobs Report emphasises the profound impact of digital transformation on the labour market. It projects that by 2025, 50 per cent of the global workforce will require reskilling or upskilling.⁹ Those in most need of this are workers who risk losing their jobs due to digital changes and those who need to learn new skills to handle evolving technologies. By acquiring software development skills, many can enhance

² McKinsey, "Securing Europe's Competitiveness: Addressing Its Technology Gap" (McKinsey Global Institute, September 2022), <https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/securing-europes-competitiveness-addressing-its-technology-gap>.

³ Gilles Babinet and Olivier Coste, "Digital Tech: Europe's Growing Gap in Eight Charts," Institut Montaigne, December 5, 2022, <https://www.institutmontaigne.org/en/expressions/digital-tech-europes-growing-gap-eight-charts>.

⁴ European Investment Bank, "Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey," 2022, https://www.eib.org/attachments/publications/digitalisation_in_europe_2021_2022_en.pdf.

⁵ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment#General_developments_in_the_demand_for_ICT_specialists

⁶ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_-_statistics_on_hard-to-fill_vacancies_in_enterprises#ICT_functions_performed_in_enterprises

⁷ <https://www.oecd-ilibrary.org/sites/290d1d69-en/index.html?itemId=/content/component/290d1d69-en>

⁸ "The Future of Jobs Report 2023" (World Economic Forum, 2023), https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf.

⁹ World Economic Forum, "The Future of Jobs Report 2020" (World Economic Forum, 2020), http://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf.

their resilience in the face of digital transformation and contribute to expanding the pool of skilled software specialists.

While the group of software specialists is too small to meet current demands, the traditional role of a software professional is also changing in the wake of emerging tools, technologies, and forms of collaboration. This requires new skills and competences. For example, soft skills are becoming increasingly important for software specialists. There is also a demand for software specialists who possess a broad range of software or ICT skills and for those with expertise in a domain other than software development (for example, marketing), so-called T-shaped and π -shaped individuals. However, existing training programmes do not equip software specialists with the necessary competences to navigate the rapidly evolving landscape of emerging technologies and industry demands.¹⁰

Besides this urgent need to grow and adapt to new technological, organisational, and economic conditions, the software development profession also suffers from a lack of representation. Women only make up 18,9% of all ICT specialists, and there is no reason to assume this is different for software professionals.¹¹ In addition to gender imbalances, there are also geographical imbalances. For example, the proportion of ICT specialists in total employment in Sweden is almost 9%, whereas in Greece, it is 2.5%.¹²

In summary, there is an economic, strategic, and inclusivity imperative to skill, upskill, and reskill individuals across Europe into high-demand software roles.

The European Commission has recognised this need. It has declared this to be “**Europe’s Digital Decade**,”¹³ the foundation of which is the **Digital Strategy** adopted in 2020.¹⁴ To reach the goals of this Digital Strategy, a **Digital Compass**¹⁵ is developed to translate the ambitions into concrete terms. Part of the first of four cardinal points in this Digital Compass is about highly skilled digital professionals. In this Digital Compass, the European Commission aims to have ten million “software developers, programmers and engineers” in the EU by 2030. Given current figures,¹⁶ the group of software professionals needs to grow by five million in the coming years.

Despite these urgent skills needs, there have been few European sectoral approaches to software skills development. This strategy provides a blueprint for spearheading these

¹⁰ European Software Skills Alliance, “Europe’s Most Needed Software Roles and Skills,” 2021, https://softwareskills.eu/wp-content/uploads/2022/10/D.4_ESSA_Europea%CC%82_s-Most-Needed-Software-Roles-and-Skills.-Needs-Analysis-Report_FINAL-draft.pdf.

¹¹ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment#ICT_specialists_by_sex

¹² https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment#ICT_specialists_by_sex

¹³ EC - Europe’s Digital Decade, available at: <https://digital-strategy.ec.europa.eu/en/policies/europes-digital-decade>

¹⁴ EC - Digital Strategy, available at: <https://digital-strategy.ec.europa.eu/en>

¹⁵ EC – Digital Compass, available at: <https://eur-lex.europa.eu/legal-content/en/TXT/?ui=CELEX%3A52021DC0118>

¹⁶ Eurostat online data code: isoc_sks_itspt

efforts. By doing so, it sets the stage for a more robust and future-ready software skills landscape in Europe.

4 Vision and mission

This European Software Skills Strategy defines the actions to bridge the skills gap for software professionals with a clear vision, mission, and goals in mind.

The vision is formulated as an ambitious shared ideal picture of a future software services sector. It serves as a compass to indicate the overall direction.

VISION

A thriving, inclusive and attractive software services sector with a sufficient and balanced supply of skilled software professionals across Europe for now and the future.

In specific terms, this vision entails that:

- The sector has grown according to the need, so there will be enough adequately skilled software service professionals to fulfil the market demand
- The sector is inclusive (gender, class, neuro-diversity etc.)
- The sector has the image of being an attractive sector to work in
- The uneven labour supply across countries has been dissolved and there will be no significant imbalances between different EU countries
- These professionals possess the right skills needed to function in the current and future software services sector.

The mission states how this vision can be realised and serves to define meaningful actions for the present and future.

MISSION

To promote and support equipping software services professionals with competences and skills to meet changing market, technological, social and environmental demands.

This mission statement contains a number of prerequisites, that are needed to achieve the vision for the sector:

- First of all, professionals who (will) work in the sector must possess the relevant skills, such as being able to adapt to change, feeling responsible for their organisation and the environment and taking into account pressing matters such as privacy, security and energy consumption. It is imperative that software professionals **are equipped with the right skills for the needed roles.**

- Secondly, this means that they must be trained. This also means that **training and education** providers need to include these skills and knowledge in their programmes and adapt their practices to enable skilling, reskilling and upskilling of as many (potential) software professionals as possible.
- Finally, actions taken will not have automatically an immediate and long-lasting effect on a large scale, so an ever-growing group of stakeholders is needed to promote and further consolidate the actions taken and ultimately anchor them in established structures and processes. **Fostering a strategic cooperation** is imperative to achieve a **sustainable development** of the software services sector as a whole for now and in the future.

This means actions need to be taken in the areas of skills and roles, training and education and with regard to cooperation.

5 Setting the stage

5.1 Strategic pillars

In order to achieve the mission, three strategic pillars have been established. They are directly related to the three key areas in the mission statement: skills and roles, training and education and cooperation.

The key elements from the mission statement are the basis for the three strategic pillars:

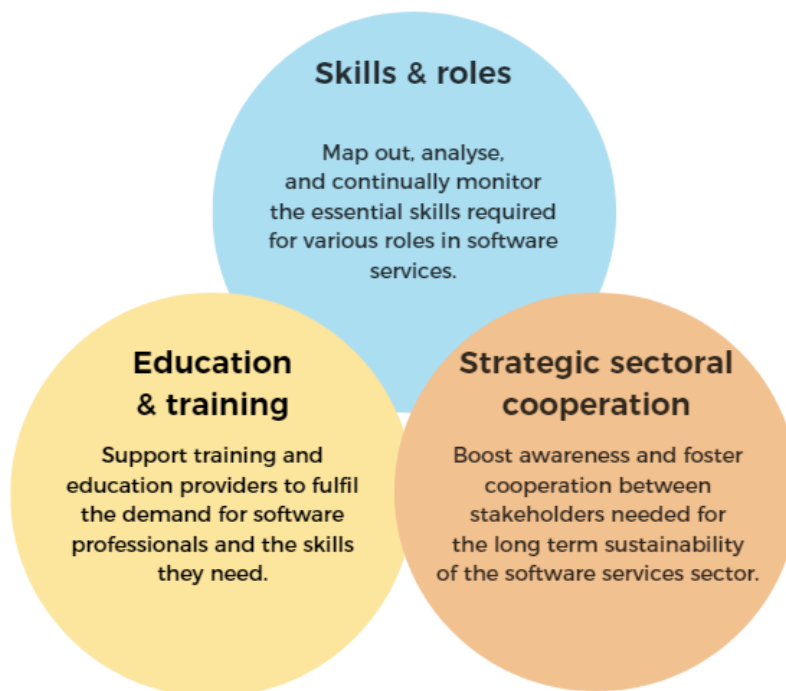


Figure 3. Mission statement vs strategic pillars

5.2 Scope of the Strategy

The European Software Skills Strategy has a clear demarcation on the subject area of software services, considering specific role profiles and competences, developing innovative learning programmes designed to match specific occupational software profiles, whilst considering the heterogenous needs of a range of stakeholders and building a strategic cooperation among them to ensure sustainability.

5.2.1 Software services

The focus of this strategy is the group of professionals working in **software services** on the **design, development, implementation and operation of software**. In this strategy, **software skills** refer to those skills these software professionals need to perform their tasks. Software skills in this strategy are *not* to be understood as the generic skills people need to effectively *use* software. The strategy is also *not* focused on ICT professional sub-domains, like data analysis, IT security, and so on.

5.2.2 Skills, competences and roles

Role profiles (occupational profiles), competences and skills are other important aspects of the scope of this strategy.

Competences are part of role profiles as required competences for a particular role. Competences are a mixture of skills, knowledge, and attitudes that enable someone to successfully perform a task or an activity within a given context.

Skills refer to a person's abilities to do something; they are essential in a professional context and are key elements of professional roles. Skills can be developed in a variety of settings. Skills may change over time, while a role may stay the same. Training in skills is therefore essential to obtain properly skilled software professionals. Having the right skills means being able to more easily stay employed and master job transitions. Therefore, it is necessary to determine the skills needed at a certain point in time and monitor and predict their changes over time. Skills development is also one of the spearheads of European policy and this is supported by, among others, the following:

- **European Skills Agenda**¹⁷: a five-year overarching plan to help individuals and businesses develop more and better skills and to put them to use.
- **Pact for Skills**¹⁸: The first of the flagship actions under this Agenda, which is a shared model for skills development in Europe, translating engagement of different stakeholders into concrete commitments on upskilling and reskilling.
- **Digital Skills and Jobs Coalition**¹⁹: tackles the digital skills gap by bringing together Member States, companies and organisations to develop localised responses to improving digital skills.
- **Digital Education Action Plan**²⁰: a renewed European Union (EU) policy initiative to support the sustainable and effective adaptation of the education and training systems of EU Member States to the digital age. "

When looking at specific roles within a professional field, a selection of those competences (skills and knowledge) has to be made that relate to the specific roles. When defining roles, competences and skills, it is good to align with already existing frameworks where possible with a special focus on the ICT professional. Therefore, the starting point for the definition of these roles are the [European ICT Professional Role Profiles](#)²¹ based on the competences listed in the **e-CF**.²²

¹⁷ European Skills Agenda : <https://ec.europa.eu/social/main.jsp?catId=1223&langId=en>

¹⁸ Pact for Skills : https://pact-for-skills.ec.europa.eu/index_en

¹⁹ Digital Skills and Jobs Coalition : <https://digital-strategy.ec.europa.eu/en/policies/digital-skills-coalition>

²⁰ Digital Education Action Plan: <https://education.ec.europa.eu/focus-topics/digital-education/action-plan>

²¹ CEN/CWA 16458-1 (2018) European ICT Professionals Role Profiles, available at:

<https://itprofessionalism.org/about-it-professionalism/competences/where-to-buy-the-e-cf-standard/>

²² General information about the e-CF, available at ITPE: <https://itprofessionalism.org/about-it-professionalism/competences/the-e-competence-framework/>. Formal information, available at CEN & CENELEC: https://standards.cenelec.eu/dyn/www/f?p=205:110:0:::FSP_PROJECT:67073&cs=15E62ED24D608A5F10D6BEE8E6D50FA10

Besides these, the [European Skills, Competences, Qualifications and Occupations \(ESCO\)](#)²³ is another important reference identifying skills, competences, qualifications, and occupations.

5.2.3 Education and training

Innovative learning programmes have to be designed and developed to match specific occupational software profiles and fulfil other market needs for example, in the way they are delivered. This implies several things. First, the learning offer must be such that it meets the demand of different types of target groups. Not only should there be opportunities for **skilling**, for instance, secondary school leavers to take an initial education in the software field, there should also be opportunities for **upskilling** for those who want to update, improve or further specialise their knowledge and skills or **reskilling** for those who want to acquire new skills and knowledge alongside a job.

Secondly, this means that the programmes should educate and train for roles, competences, knowledge and skills that are indicated as central to this strategy and that the focus of the **learning programmes must be aligned with the requirements in these specific occupations** or more broadly on the software labour market.²⁴ This is a typical definition of vocational education and training (VET). However, VET often is incorrectly associated with lower levels of complexity in education and training. Therefore, in this strategy, the term “learning programme” will be used instead of “VET programme”.

To be precise: The relevant **learning programmes** in the context of this Strategy are **VET and higher VET** and range from complexity levels **EQF 3/4 up to levels EQF 6/7**.²⁵

The programmes must be directly related to and prepare for the occupational field. Especially on the higher levels of complexity extra attention has to be paid that the programme is really focused on the occupational and market needs and is not an academic programme with a scientific orientation or a general education.

The aim is to educate or train learners to obtain learning outcomes, leading to qualifications that are recognised by national education authorities (or equivalent). Therefore, the Strategy focuses on formal learning. At the same time the importance of non-formal and informal learning in skills development is recognised. The **validation of competences and skills** acquired in those ways is important in relation to software professionals, as they often use non-formal and informal ways of learning to upskill themselves.

5.2.4 Stakeholders

²³ ESCO, available at: <https://esco.ec.europa.eu/select-language?destination=/node/1>

²⁴ Cedefop, glossary of terms, definition of VET <https://www.cedefop.europa.eu/en/tools/vet-glossary/glossary?letter=V>

²⁵ This incorporates: Upper secondary VET (EQF 4), Post-secondary / tertiary VET (EQF 4 and 5), and higher VET (EQF 5, 6, 7).

Stakeholders are any group that can affect or is affected by the achievement of objectives.²⁶ The skilling, upskilling, and reskilling of individuals into high-demand software roles across Europe is of relevance to a large number of stakeholders, which can be divided into “primary” and “secondary.”²⁷ A primary stakeholder group is one without whose continuing participation an enterprise cannot survive as a going concern. While secondary stakeholder groups are not essential, their involvement determines the success of that enterprise. The list below presents the relevant stakeholders, identified through a stakeholder mapping process, and highlights their respective roles and interests in relation to software skills. Figure 2 provides an overview of this classification.

Primary Stakeholder Groups

- **Potential learners:** Software skills training ultimately targets three types of learners: (1) people following/wanting to follow initial education in software roles (to skill), like secondary and tertiary level students, (2) professionals working in software roles (to upskill), (3) professionals in other roles and job seekers that want to work in software roles (to reskill). Software professionals from all these groups will be needed to fill the software-related ICT vacancies in the coming years.
- **Education and training providers:** Education and training providers are pivotal in delivering the software learning programmes. The group of formal learning providers consists of four subgroups: (1) VET providers, (2) higher VET providers, including higher education institutes, (3) internal training departments of organisations, and (4) independent trainers/ teachers.
- **Organisations in search of software skills:** Apart from learners, the ultimate beneficiaries of software skills are organisations hiring software professionals. These firms are also crucial by providing employment opportunities. These organisations can be categorised into two main groups: IT organisations (large and SME) developing software solutions and other organisations with their own software development needs. In addition, a third group includes organisations with the delegated task of finding software personnel with the right skills, such as recruitment agencies and employment services.
- **Validation organisations:** This group consists of all those organisations that use assessment procedures and a set of predefined criteria or a standard to validate if an individual, a learning programme or a provider complies with the criteria or standards of software learning programmes. The group is composed of accreditation bodies and certification institutes.

Secondary Stakeholder Groups

²⁶ R. Edward Freeman, *Strategic Management: A Stakeholder Approach* (Boston, M.A.: Pitman, 1984).

²⁷ Max B. E. Clarkson, “A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance,” *Academy of Management Review* 20, no. 1 (1995): 92–117, <https://doi.org/10.2307/258888>.

- **Policymakers:** National- and European-level policymakers are important stakeholders since they shape the regulatory and educational environment, directly influencing the availability and quality of software training programmes. Their decisions regarding funding, curriculum standards, and workforce development policies can significantly impact the success and accessibility of the software learning programmes. Some examples of policymakers directly involved are the European Commission (DG EMPL, EAC, GROW, and CNECT), the European Parliament (CULT, IRTE, and EMPL), European agencies in the education and employment arenas (e.g., CEDEFOP, ESCO), and national policymakers that determine VET curricula, accreditation, and certification.
- **Associations and networks:** This is a broad and diverse group of chambers, networks, associations, and umbrella organisations representing primary stakeholders, thus having an interest in software skills. This group of associations and networks include, for example, European associations of VET providers, university networks, chambers of commerce, and industry groups.

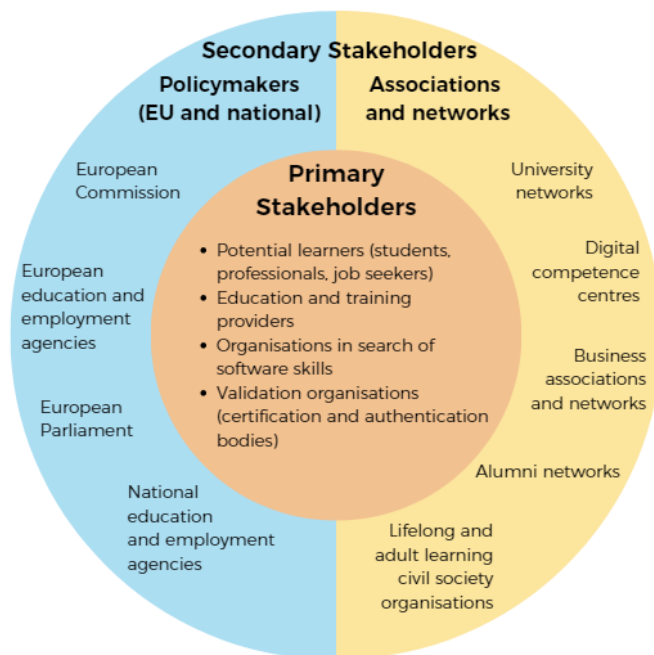


Figure 4. Primary and secondary stakeholders of this strategy

6 Strategic objectives

The three strategic pillars this strategy is built on relate directly to the key elements of the mission statement:

- (1) analysing and monitoring the right skills for software professionals,
- (2) supporting the provision of training and education and

(3) creating strategic collaboration between key stakeholders.

Each pillar is translated into two concrete objectives, turning the general statements of what is to be accomplished into specific, quantifiable statements with specific actions and timelines. This ensures that all actions are aligned with objectives, mission and ultimately will support the thriving, inclusive and attractive software services sector as envisioned in this document.

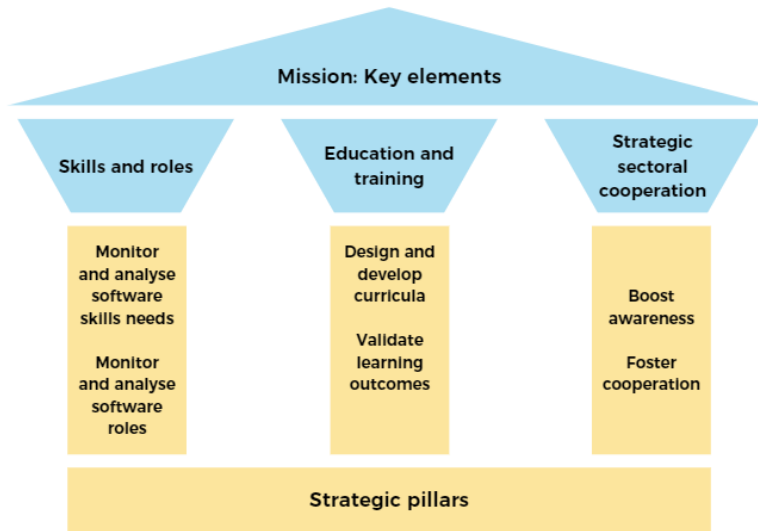


Figure 5. Strategic pillars and objectives

Each strategic objective leads to certain key actions which will specified further in the following chapters.

Strategic objectives	1. Monitor and analyse skills needs	2. Monitor and analyse market-oriented software roles	3. Design and develop harmonised curricula	4. Validate learning outcomes	5. Boost awareness	6. Foster cooperation
Actions	<p>Identify urgent skills needs for software professionals</p> <p>Identify emerging skills needs for software professionals</p>	<p>Monitor developments in existing software related roles</p> <p>Identify emerging software related roles</p>	<p>Develop and maintain European educational profiles for software roles</p> <p>Design curricula and implement learning programmes tailored for specific contexts</p> <p>Develop and maintain learning materials</p>	<p>Design and implement a certification scheme for software professionals</p> <p>Design and implement a quality label for learning providers</p>	<p>Develop and implement a communication strategy</p> <p>Build and maintain a software online community</p>	<p>Build and foster a software sector alliance</p> <p>Connect to European standards and initiatives</p> <p>Develop and implement a European software sector mobility programme</p>

Figure 6. Table European Software Skills Strategy: Strategic objectives and actions

7 Skills and roles

The first strategic pillar of this strategy is to monitor and analyse the right skills for the needed software services roles. Skills and roles are at the very core of this strategy.

Skills are fundamental abilities that software professionals need to perform their jobs effectively. These skills encompass a wide range of proficiencies, which are clearly not limited to only hard technical skills. Skills come together in the competences people have and in the roles people perform with specific tasks and responsibilities. Skills and roles go hand-in-hand.

Strategic objectives 1 and 2 both focus on identifying which skills and roles are relevant for software professionals and then monitoring developments in these.

7.1 Strategic objective 1. Monitor and analyse skills needs

EU policy recognises²⁸ that skills are essential for sustainable competitiveness. Companies need workers with skills to cope with the digital transition. However, increasing skills shortages, gaps and mismatches is creating bottlenecks. Software professionals are at the heart of EU's digital transition and training in the right skills is therefore essential to obtain properly skilled software professionals to overcome skills shortages and mismatches. These skills should also be the central part of skilling and reskilling programmes. The workforce needs both sector-specific skills and more transversal skills, which combine domain-specific knowledge with problem-solving and interpersonal skills. Companies struggle to find workers with these skills and report that this slows down their investments.

7.1.1 Identify urgent skills needs for software professionals

To identify the skills needs for software professionals, a research was conducted²⁹ using different data collection techniques and different target groups. An extensive desk research was conducted to study the current and future demand at both European and national levels. This included a literature study, an analysis of market and trends reports and an analysis of job vacancies. In addition, a questionnaire was distributed to organisations with software skills needs to ask them about their current demand.

All the outcomes from the different research methods were quite consistent and showed that besides typical "hard" skills, like programming and the ability to handle algorithms, other skills are also desirable and needed for software professionals. These are broader ICT skills, such as being able to apply principles of security and being able to work in projects. Also mentioned are interpersonal skills related to communicating and functioning in teams, and more personal skills such as problem solving.

²⁸ https://ec.europa.eu/commission/presscorner/detail/it/qanda_20_1197

²⁹ ESSA Needs Analysis, 2021

A key finding is that the skills needed in software roles and jobs are certainly not limited to **hard skills**, but include broader **profession-related skills** and **soft skills** needed to be successful as a software professional. These skills are found to be highly relevant to all the roles that software professionals fulfil.



Figure 7. Overview of essential skills for software professionals

Hard software skills

Hard software related skills are primarily focused around programming skills,³⁰ but besides these there are also other related hard skills that are relevant in software roles. The hard skills are job-specific technical skills that are directly related to the production and maintenance of software.

There is no gap in **programming skills** in terms of content as there is a large availability of programming courses. The most requested programming languages by organisations, like Python and Java, are widely taught in VET programmes and all kinds of training programmes are available to learn these languages. Learners can choose between online, in-class and hybrid forms of education and training and can also learn for example by the numerous books and all kinds of online materials that are available. The result is that there are enough software professionals that possess these programming skills as a professional. The most needed **programming languages** at the moment are: Java, JavaScript, SQL, HTML, PHP, C++, C# and Python.

It is to be expected that in the (near) future other programming languages will become more important, which will lead to the need for upskilling and adjustments in skilling and reskilling programmes. It will help to speed up and ease these processes if software professionals have a strong foundation in **general programming principles**.

³⁰ ESSA Needs Analysis

Besides programming skills, there are other essential hard skills related to software production and maintenance.³¹



Figure 8. Essential hard software skills

The ability to work with **algorithms** is very important. Organisations have a substantial need for people with skills in this area. There is also a substantial need for skills related to **testing** and to **DevOps**, both are considered almost equally important. Skills related to **cloud** and **open source** are in demand. The European Commission considers them enablers for the implementation of the Commission’s overarching Digital Strategy, as described in the [European Commission Cloud Strategy](#)³² and in the [Open Source Software Strategy 2020-2023](#).³³ In addition to the importance the Commission attaches to these developments, many experts and reports at national and European level also consider practices related to open source and cloud essential to businesses.

Profession-related skills

Profession-related skills are needed to perform well as a software professional, but also many other professionals operating in the field of ICT need these kinds of skills.³⁴

³¹ ESSA Needs Analysis

³² European Commission Cloud Strategy - Cloud as an enabler for the European Commission Digital Strategy. Version 1.01, 16/05/2019, available at: https://commission.europa.eu/publications/european-commission-cloud-strategy_en

³³ European Commission – Open Source Software Strategy 2020-2030; Think Open. Brussels, 21.10.2020. C(2020) 7149 final, available at: https://commission.europa.eu/documents_en?f%5B0%5D=document_title%3Aopen%20source%20strategy

³⁴ ESSA Needs Analysis

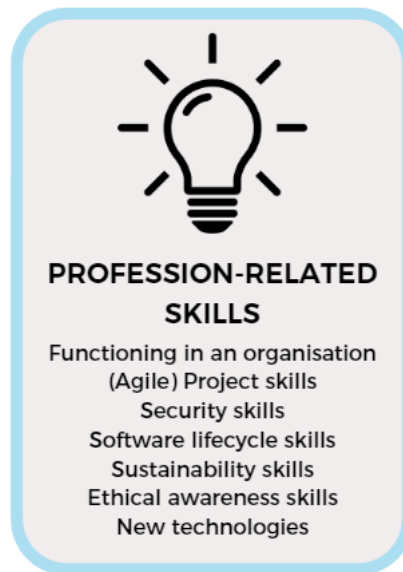


Figure 9. Essential profession-related skills

Many software professionals are working in an organisation. An **understanding of the business context**; the basic underlying principles of organisations, their culture, structure and processes and the way people behave in organisations will not only greatly support them in their own professional careers but will also be valuable to the organisations in which or with which they work. As a software professional, it is necessary to have an understanding of the broader context of one’s activities and tasks. This includes also a deep understanding of the whole **development lifecycle**, which is especially important when it comes to continuous integration and continuous deployment (CI/CD). Another essential aspect of functioning in an organisation is cooperation. A software developer does not work alone but is working together with other people and different experts in projects and teams. **Project skills** are important in general and **agile project skills**, in particular, are becoming increasingly important since more and more projects and teamwork are organised in this way.

Software professionals must be up to date with the latest developments and not only should be aware of **new technologies** in their field, but they should preferably be able to apply (basic) methods, techniques and tools related to that new technology and understand its possible advantages and disadvantages. The same holds for **security, sustainability and professional ethics**. These are all topics that are already important and are gaining more relevance and software professionals are expected to align their practices with requirements related to these specific areas. In relation to the ambitions of the EU, following the Sustainable Development Goals (SDGs)³⁵, it is expected that **sustainable software development** will become important.

Professional ethics is another topic that is on the rise. as there is an increasing disquiet from the public and some governments over the potential of software to cause harm, either through malicious misuse

³⁵ UN Sustainable Development Agenda, available at: <https://www.un.org/sustainabledevelopment/development-agenda/>

or the inadvertent negative effects of lack of due care. This is most notable in terms of software with a high public profile, such as AI, but the design of algorithms in general is no longer assumed to be an ethically neutral activity. The “Do No Harm” (DNH) principle is considered very important in this respect. For current and future software professionals it is becoming increasingly important that they have the skills to critically evaluate, discuss and when necessary, report and mitigate any ethical concerns regarding the software they are developing. Being accountable and acting responsibly and reliably are becoming an integral part of working as a software professional. This will also soon be a regulatory requirement as developments on regulating data analysis and AI become more established and is increasingly seen by companies as an important reputational issue. It is also a strong area of interest for ICT professional bodies and many of the larger computing professional associations, for example the ACM, insist on some ethics content for computing courses they accredit.

Soft skills

The skills needed in software roles are certainly not restricted to hard software skills and profession-related skills. Soft skills in particular have become essential skills for almost every professional, and they are certainly for software professionals. Typical of the software sector is working in projects and teams with users, clients and different disciplines. Soft skills enhance the performance of software professionals within an organisation, making them more deployable in different teams and settings.

Soft skills also increase employability and mobility in general, as the skills themselves are transferable and are also useful and necessary in other professional fields.

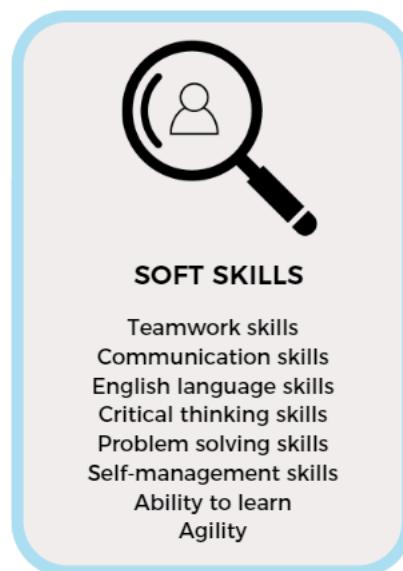


Figure 10. Essential soft skills

People in software roles need interpersonal soft skills since almost all activities in these roles nowadays require working together. The most relevant are **teamwork** and general **communication skills**. In most cases teamwork and communication skills are already part of educational programmes, but they need to be the focus of more attention, especially in relation to working in a business environment.

English is important in a lot of jobs, so **English language skills** are important and may even be a foundational requirement especially in relation to mobility.

Personal soft skills are becoming increasingly important for people in software roles. The most important are **critical thinking and analysis, problem solving, self-management** and **an ability to learn** combined with **agility**: the flexibility to **adapt to change**.

A willingness and ability to learn is relevant to software professionals as new technologies and shifting roles and work practices are common practice in the software sector.

7.1.2 Identify emerging skills needs for software professionals

To identify the future demand for new or emerging skills and roles, expert groups were used to gain insights into future scenarios. This was done synchronously during online meetings on national levels and on European level. Also, desk research was conducted, gathering secondary data, mainly by studying labour market prediction reports at national and European level.

Besides collecting valuable insights and information, the expert groups also function as a carriage to involve stakeholders and foster essential partnerships, supporting the recommendations of this Strategy (strategic objectives 5 and 6) and embedding them in local contexts.

7.2 Strategic objective 2. Monitor and analyse market-oriented software roles

One of the key requirements for meeting the software needs of the market is that the roles for which software professionals are trained and educated meet them. It is therefore a matter of defining a set of key software roles that, on the one hand, is general enough to be manageable and straightforward, i.e. without going into too much detail and, at the same time, also matches the details mentioned in job advertisements.

7.2.1 Monitor developments in existing software-related roles

There is a huge number of different job titles in the ICT sector and they are created for various purposes. Jobs are unique, but a similar title can be used to describe very different jobs, and conversely, similar jobs can be described by different titles. So, while there is generally a common understanding of a particular function, in practice there are many variations on it, tailored to the specific context of e.g. an organisation or country. A distinction must therefore be made between specific jobs and more generic role profiles.

Role profiles offer structure and clarity by clustering typical and common job components into a consistent role profile description. They are less detailed and less specific than job descriptions. Because of the higher level of abstraction, well-defined role profiles can be regarded as archetypes, from which all functions in practice are derivatives and further specifications. A well-described set of role profiles is therefore clearly distinguishable and recognisable and can be used as a basis for many activities, including personal development, curriculum development and training. Good profiles are designed to be consistent in structure but varied in content and provide a clear differentiation between each profile.

Role profiles

The European ICT professionals role profiles³⁶ offer such a structure and provide a generic set of 30 ICT role profiles. Five of these role profiles relate to the software professional as referred to in this strategy, having software development and operation as an essential element of their role. The selected role profiles are the **developer**, the **DevOps expert**, the **solution designer**, the **test specialist**, and the **technical (software) specialist**. Additional research endorses this selection.³⁷

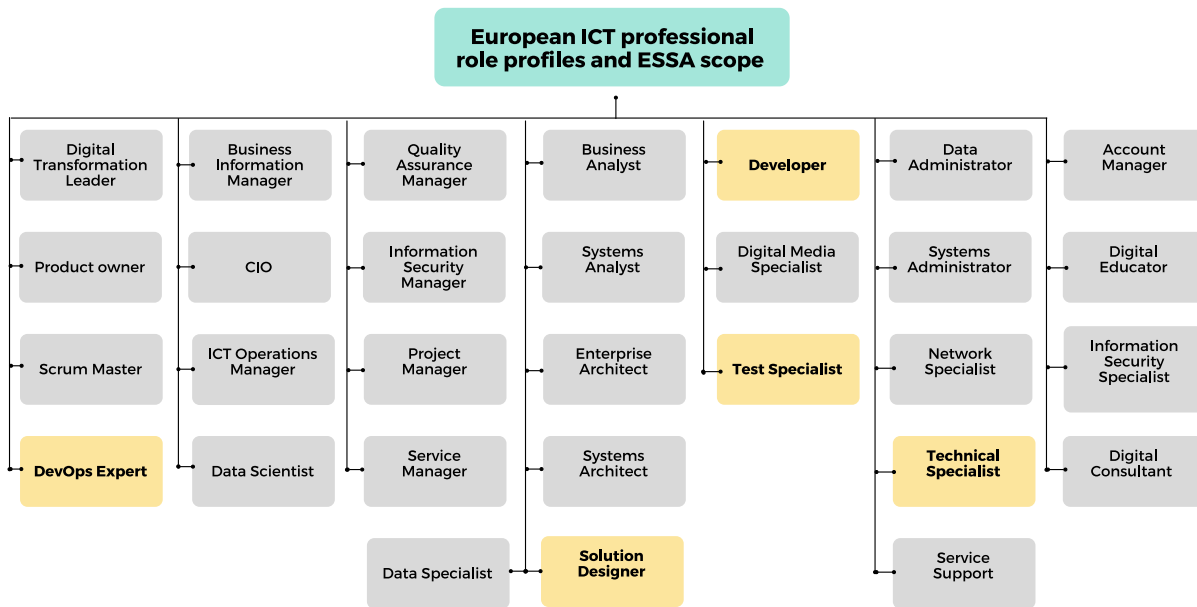


Figure 11. European ICT Professional Role Profiles versus software professional roles

These role profiles have a fairly high level of abstraction, so organisations need to add more details to meet their particular needs. Based on the findings of the research³⁸ done in the context of this Strategy, the selected role profiles are adjusted and expanded³⁹.

The European Skills, Competences, Qualifications and Occupations (ESCO) classification identifies and categorises skills, competences, qualifications and occupations relevant for the EU labour market and education and training. ESCO covers a wide range of occupations found in the EU, a much broader range than the ICT profiles, and it is elaborated at a higher level of granularity in the identification of

³⁶ CEN Workshop Agreement (2018). CWA 16458-1 European ICT professionals role profiles - Part 1: 30 ICT profiles. Brussels: CEN. Available at: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN%20sectors/Digital%20Society/CWA%20Download%20Area/ICT_SkillsWS/16458-1.pdf

³⁷ ESSA Needs Analysis

³⁸ ESSA Needs Analysis

³⁹ See: ESSA Booklet Software Professional Role Profiles

job profiles. Annex 3 contains a table that matches the five software role profiles with corresponding ESCO roles.

The five selected software role profiles have been assessed against the current and projected market needs⁴⁰ and a weight that reflects their relative importance was added to each profile. This relative importance of the five software roles is depicted in a priority list that guides skilling, upskilling and reskilling activities.

Role	Now	In 5 years
Developer		
DevOps expert		
Solution designer		
Test specialist		
Technical specialist		

Figure 12. Relative importance of software roles

Although in other roles software-related aspects may play a role to a certain extent, these roles are out of the scope of this strategy, as the software aspect is neither essential to that role, nor does it comprise the largest portion of skills, knowledge, competences, and tasks related to that role. People in other roles like Data Specialist, Service Support, or Information Security Specialist may need software skills to a certain extent to perform their jobs, but their jobs are not defined nor characterised by software skills. In these cases, other skills are often more essential, and even with limited software skills it is possible to perform the role.⁴¹

Different shaped professionals

A key development that is to be noted is the need for T-shaped and π-shaped professionals in the software sector.

Many software professionals are still specialists with a single specialty. They are so-called “I-shaped” professionals. They have deep and thorough knowledge and skills in one specific area represented by the “I” vertical line. These are very valuable professionals, but it is for example hard to work with them

⁴⁰ ESSA Needs Analysis

⁴¹ ESSA Needs Analysis

in multi-disciplinary teams. This is because they don't possess the right skills to work together with people and they particularly struggle to work in diverse teams with people from other disciplines.

T-shaped and π -shaped professionals are professionals that possess the skills to work together with other disciplines, hence the horizontal bar. The broad part refers to a skill set and attitude that form a base for cooperation with other kinds of specialists from other fields. The π -shaped professionals have two specialisations, hence the two vertical lines. There are also other variations called m- and comb-shaped professionals indicating 3 or more specialisations, but the principle is the same as the π -shaped professional⁴².

In the short term, there is an absolute demand for T-shaped software professionals. So, important is to ensure software professionals are no longer just I-shaped, but that they are all at least T-shaped. The broader skillset consists of profession-related skills, that are relevant to the broader ICT sector and of soft skills not only relevant in the software profession but also relevant in other professional fields and domains.

The focus should also be on creating π -shaped professionals by reskilling professionals from other fields. Professionals with two specialisations that can be combined will be needed in software services. These kinds of professionals can be of great value to an organisation, as ICT has become an integral part of many organisations and not just a standalone function. Having an expertise in software development and in a different professional field creates an added value. Good examples are a combination of marketing and ICT or finance and ICT. Reskilling people from other fields will create these professionals.

Profession-related and soft skills enable people to develop specific hard skills easier, but also to work together in a team with different disciplines, to communicate with others and understand different perspectives from different fields easier. Furthermore, possession of these skills provides people with a broad reach, allowing people to switch between jobs and are essential for reskilling. These are the skills of which the horizontal bar of the T- and π -shaped software professional are largely composed of.

7.2.2 Identify emerging software related roles

To identify the future and emerging software related roles, expert groups were used. This was done synchronously during online meetings on national levels and on European level. Experts were explicitly asked about their insights and opinions regarding the demand for software roles in the short term and in the long run.

New roles like AI Developer, VR/AR designer, full stack developer and blockchain developer are all specialisations of the more general five role profiles, so are already covered by these profiles. In the

⁴² Other variations of combinations of skill sets are E- and X-shaped professionals. E-shaped professionals combine experience, expertise, exploration, and execution, with an emphasis on the last E of execution, translating ideas into reality. X-shaped are those that combine their depth of knowledge and breadth of work with high credibility, plus the ability to lead a diverse team to achieve a common goal. These more complex shaped professionals will become more predominant in the long run, when new skillsets will be needed due to the developments in technologies and work practices.

review process of the strategy this finding was confirmed. These specialisations can be grouped as follows:

(1) Cloud, (2) Open Source, (3) Data, (4) AI/Machine learning, (5) Sector specific (e.g. fintech), (5) Other, e.g. IoT/ mobile, robotics, blockchain, AR/VR.

8 Education and training

Having identified the skills needs, the second strategic pillar of this strategy is to support training and education providers to fulfil the demand for software professionals and the needed skills.

8.1 Strategic objective 3: Design & develop harmonised curricula

The design and development of harmonised curricula to address the skills needs in a market-oriented way is crucial. These are potentially contradictory elements, since in a lot of cases “harmonised” is translated as using the same delivery methods and learning materials, while on the other hand, the learning should be tailored to the needs of the specific situation. Somebody already working in ICT for over ten years and in need of some upskilling, will need different training than somebody completely new to the field. Also, for example, other programming languages can be needed in one country or region than in another one.

The answer to this possible contradiction is to work with educational profiles that define learning outcomes as the method of harmonising. This means that the outcomes of the learning will be comparable and not the specific way of learning. Learning programmes can differ, but the end results in terms of learning outcomes are the same.

Harmonising on this level also has the advantage that education and training can be more effective and efficient. It allows for flexibility and modularity which directly links to individualised pathways with micro-credentials and the recognition of earlier acquired skills.

This also means that the role of learning materials will be different, since they are no longer the primary tool for harmonising. The sharing of learning materials will still be important to share ideas on efficient knowledge transfer and for quick uptake of the curricula by new providers that perhaps don't have all the materials for all topics available themselves already.

8.1.1 Develop and maintain European educational profiles for software roles

The educational profile

The European Committee for standardization (CEN) has described the method of using educational profiles to translate market demands into learning programmes.⁴³

It is a method that enables competence-oriented curriculum design as it translates market needed occupational profiles, competences, skills, and knowledge into educational terminology by formulating a set of programme learning outcomes, corresponding unit learning outcomes and assessments. Besides this, also a description is added with characteristics of the profile, independent of detailed design aspects of a concrete curriculum.

In this way a blueprint is created, which represents the market demand in educational language and forms the foundation to design curricula and develop learning programmes.

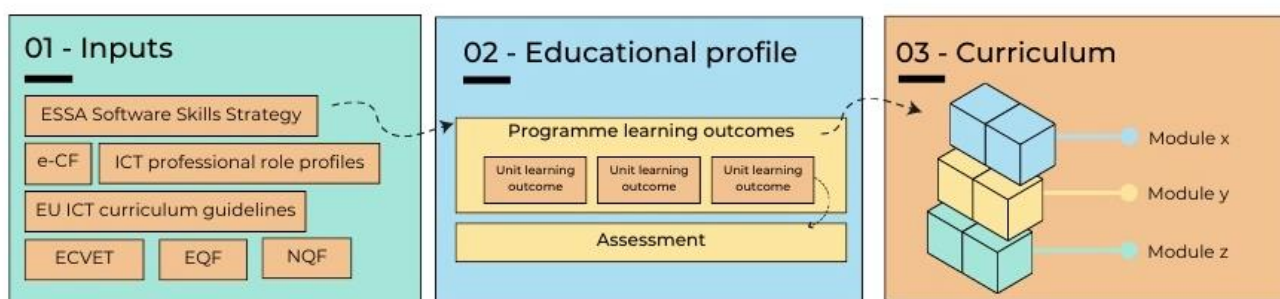


Figure 13. The role of the educational profile

Educational profiles for software roles

The most important input for the educational profiles are the market needs and those needs are represented by the software services role profiles. There are five identified key general software services roles, but looking towards education and training there must be differentiated in the complexity of different specific applications of these roles. This is done by using the EQF identifying the complexity of education and training in levels. By identifying the relevant levels for each role, a total of 9 educational profiles can be distinguished.

⁴³ CEN/TC428 (2022) Guidelines for developing ICT Professional Curricula (TS 17699), available at: https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0:::FSP_PROJECT,FSP_ORG_ID:72363,1218399&cs=169E9940F2911D404FAE0D4872E5D2630

European Qualification Framework (EQF)	EQF 7	ESSA Senior Developer	ESSA DevOps expert	ESSA Solution designer		
	EQF 6	ESSA Developer	ESSA Junior DevOps expert	ESSA Junior Solution designer		
	EQF 4/5	ESSA Junior Developer			ESSA Test specialist	ESSA Technical specialist
		Developer	DevOps expert	Solution designer	Test specialist	Technical (software) specialist

Software Role

Figure 14. The nine key educational profiles for the software services sector

The competences that professionals need according to the role profiles are translated to programme learning outcomes on the relevant EQF-levels. A number of programme learning outcomes are not relevant for just 1 profile, but for more or even all profiles at a certain level. This leads to an overview of programme learning outcomes relevant for the software roles.

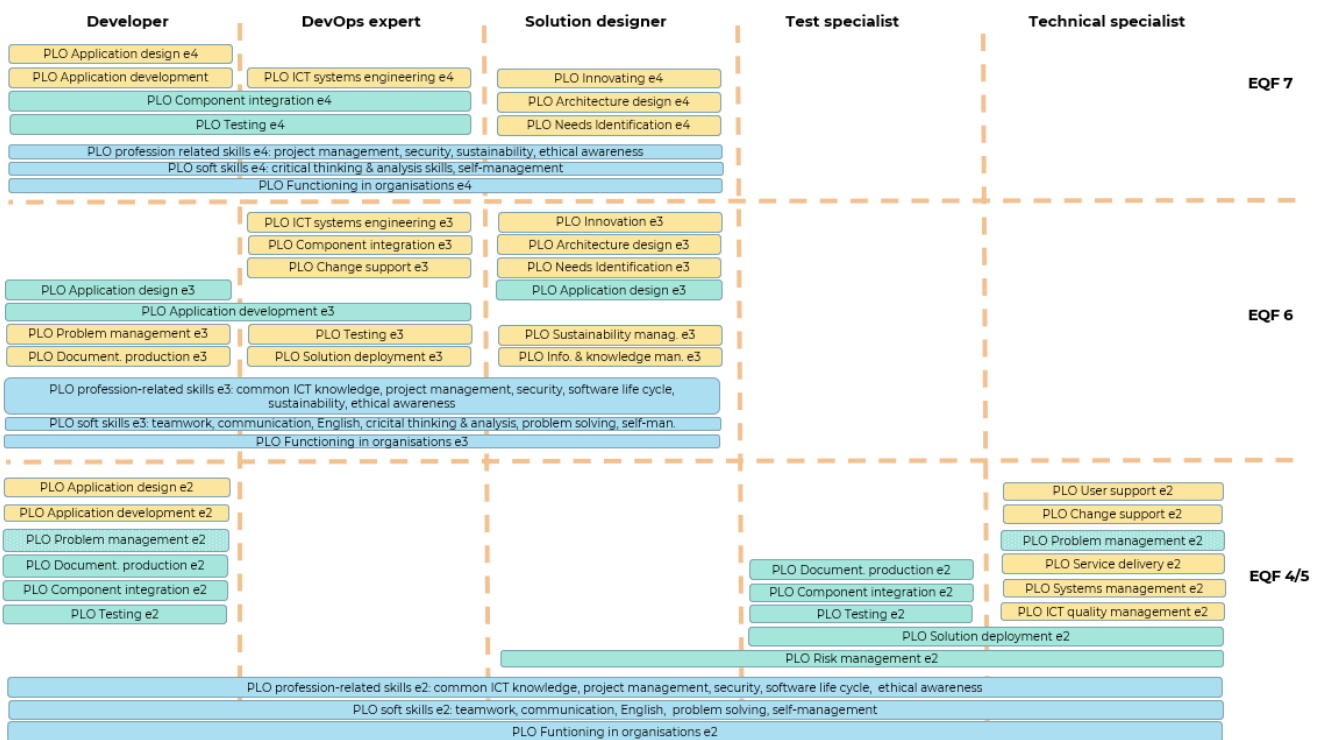


Figure 15. The programme learning outcomes in the context of the educational profiles

The programme learning outcomes are refined further by defining unit learning outcomes (ULO). Each programme learning outcome has a set of unit learning outcomes that together lead to the programme learning outcome.

Another important element is the assessment since it must be validated whether somebody actually did obtain a certain learning outcome.

All this results in [9 educational profiles](#) central and essential for the software services sector⁴⁴.

Updating the educational profiles

The educational profiles need to be updated regularly for example due to changes in the role profiles that originate in changes in the market needs. There are also other potential changes to keep in mind like changes in the EQF or the e-CF. The way that the programme and unit learning outcomes are formulated, they will in most cases not have to be adjusted due to new technology or new methods and tools in the field, but on occasion this could also be a reason to make changes in the educational profiles. A regular, preferably yearly, check whether the educational profiles are still up to date is therefore needed.

8.1.2 Design curricula tailored for specific contexts

Tailored curricula

The skilling, upskilling, and reskilling of people is key to increasing the number of software professionals. This includes initial educational programmes that skill new, young professionals, upskilling programmes that keep software professionals up-to-date, and reskilling programmes to reskill other professionals to become software professionals. These target groups each require different curricula to obtain the needed learning outcomes, and consequently learning programmes. In other words, the learning outcomes that are obtained are the same, but the way to do that differs.

Initial learners are skilled in formal, initial education starting from EQF4 level, but mostly on higher levels all the way up to EQF7 and EQF8 level given the increasing complexity of the profession. It is necessary to educate broad professionals that on the one hand can keep up with changes in the field, but also can operate within a business environment and have the (soft) skills to work together with other professionals within an organisation or project. It is therefore essential that this kind of skills are part of the initial education of software professionals on all EQF levels. This results for this target group in curricula that need to cover all the programme learning outcomes of a complete educational profile.

Software professionals in need of upskilling will in most cases want to focus on specific technical learning outcomes related to for example new technologies. Besides that, attention also needs to be paid to soft skills and function in organisations skills, since organisations indicate that software

⁴⁴ See: ESSA Educational Profiles for Software Roles: <https://softwareskills.eu/library/essa-educational-profiles-for-software-roles/>

professionals are lacking these skills or at least can use an upgrade of those skills. In general they have little time for upskilling, so they require flexible, very efficient curricula.

Reskilling professionals from other fields to become software professionals will create professionals with expertise in multiple professional fields, like π -shaped or even comb-shaped professionals, that can bridge two fields or more. The professional can either start as an I-shaped or a T-shaped professional, but both will be trained to become a π -shaped professional. The advantage of reskilling π -shaped professionals is of course that they already know the business domain. Curricula designed for this target group will mainly focus on the more technical, software related learning outcomes. In case of a specialised I-shaped professional the learning programme will also need to pay attention to learning outcomes related to soft skills that are needed to bridge the two fields.

Localisation of curricula

Besides these different target groups also other aspects can lead to another specific learning need. For example, in one country, region, or industry the AWS cloud is dominant, but in another it is Microsoft Azure. It is logical that a learning provider uses the dominant platform in their environment to teach about cloud, so although in both cases learners need to achieve the learning outcome related to cloud fundamentals, in the one case they will do this using AWS and in the other using Azure. Other examples of local needs might include a specific programming language commonly used in a certain region or key industry. It may also be that a specific profession-related skill or soft skill is particularly important given the national or regional situation.

The learning outcomes defined in the educational profiles are formulated in such a way that it is possible to meet specific local demands and still be in line with the profile. An educational profile and its learning outcomes can be translated in a general curriculum, but it will always be specific instances that are implemented since they are tailored for the target group, local situation, and perhaps other relevant factors.

Individualised pathways

Even if curricula are tailored to the target group and localised inline with specific situations, there still remains a difference in individual learning needs. For example, two experienced software professionals in need of upskilling can both have different learning needs due to differences in education, training, and experience in projects and organisations. To reach the same learning outcomes they need different training. In other words, they need individualised learning pathways to obtain the same learning outcomes.

Exemptions are one of the instruments to create individualised pathways. Prerequisite for that is assessing whether somebody already obtained a certain learning outcome. Assessment criteria must therefore be developed to facilitate individualised pathways. Exemptions of parts of a curriculum are key for efficient reskilling because the use of well-designed exemptions reduces needless and tedious repetition. These speeds up the completion of the programme and makes it more attractive for students and employers.

Another perspective is to develop more than one way to achieve a learning outcome. Some learners learn, for example, better if they listen to the material while others prefer reading or visual information. It is also easier for some people to train a certain skill in their real-life working environment while for others this is not possible. The same learning outcome can be achieved using different learning methods.

Modular curricula

An important tool that enables flexible, individualised learning pathways is modular curriculum design. Dividing a curriculum into small learning units increases flexibility, for example since learners can choose to do only the parts relevant to them. It allows them to compose the content of their education flexibly by combining different modules.

A modular curriculum consists of small discrete modules or learning units that are virtually self-contained, independent, nonsequential, and typically short in duration. This means that a learner should be able to do a learning unit without having to do others before or after that. There can be of course be prerequisites for a learning unit, but those should be formulated in terms of learning outcomes somebody already needs to have reached before participating in a certain learning unit. It also means that every learning unit should have an assessment independently of other learning units for achieving the intended learning outcomes. Short in duration is a relative term, but can range from a few hours to several hundred hours of learning in a learning unit.

A modular curriculum also facilitates possibilities of micro-credentialing or other kinds of credentialling. Every learning unit can be recognised with a credential which showcases the achieved learning outcomes. These credentials can be used independently or be stacked to achieve an overarching credential or qualification.

Designing tailored curricula

Harmonising between different learning providers takes place on the level of learning outcomes, which results in learning providers being free in designing their curricula tailored for their specific situation. The most important aspect is that is shown which learning outcomes are achieved in which learning unit. The way easy way to show that is to create a learning unit for each learning outcome, but in a lot of cases this is not feasible or even logical. Therefore, in many cases multiple learning outcomes are covered in one learning unit. It can also be that one learning outcome is not covered in one learning unit, but spread across multiple. This is not ideal, because in that case a learner has to complete multiple learning units before getting credentialled for that learning outcome. In the end, the only thing that matters is that it is clear that the relevant learning outcomes are covered by the set of learning units that form the curriculum.

The fact that each provider can design its own specific curricula does not mean that they will necessarily be completely different, since they are aimed at reaching the same learning outcomes. Every curriculum is an instance of a general curriculum that would reflect an overall way of reaching this set of learning outcomes. To facilitate the uptake of the educational profiles in curricula, guidelines are formulated for each profile on the level of programme learning outcomes. These guidelines provide examples on how to design the curriculum for a certain programme learning outcome given a specific

situation. These guidelines can be translated to the own situation and in that way learning providers are supported in designing tailored curricula.

8.1.3 Develop and maintain learning materials

The role of learning materials

The fact that harmonising takes place on the level of learning outcomes, not only means that curricula will differ between providers, but as a consequence of that also each learning provider can use different learning materials. Still the free provision of up-to-date training materials supports education and training. It facilitates the uptake of the curricula since providers can directly use available materials and it increases the quality learning materials since providers can build on each other's work.

It is inevitable in a field like software services that learning materials (and methods) will need to be updated on a regular basis. The collaboration between learning providers and organisations with the need for software professionals will also provide insights on the extent to which the provided learning materials are up to date and that also contributes to the quality of materials used in the learning programmes. The first step is that methods and materials must be up to date to start with. Given the software skills gap, it can be assumed that part of the methods and materials currently used are outdated. New materials must be developed that cover the latest technologies and trends. The second, more difficult, but important, step is to keep the training up to date. Because of the time and effort invested, it is very tempting for educators and training providers to keep the methods and materials stable for (at least) a couple of years. But this can result in out-of-date training, so mechanisms must be put in place to identify emerging needs and facilitate updating methods and materials when needed. It requires a system of continuous improvement and delivery to stay up to date in education and training provision.

A learning platform that contains materials educators and trainers can use, but also update, helps to do this. This repository increases uptake since learning providers have a good starting point for their own materials using the materials as they are or adapting them to their specific situation. Besides that the materials can at the same time be updated and improved. This increases quality and ensures being up to date.

Flexible learning and learning materials

People's workloads differ and may change sometimes in very short periods of time. Therefore, the idea of "self-paced learning when possible and instructor-paced learning when needed" is important and must be promoted. Learning that can be done at a suitable time and at a pace that is manageable for the learner will drastically increase opportunities for learning. It will lead to more professionals being upskilled and reskilled. It is also an effective way to widen access to initial education for working students or potential students that have other commitments. Self-paced learning requires different learning materials than instructor-led learning. The teacher should be involved in the materials as much as possible. This means more context and explanations in e.g. text or video.

It must also be recognised that teachers and instructors have added value in the learning process. A lot of delivery methods in education and training depend on the teachers and trainers and their expertise. Expertise, in this case, consists of software related skills including soft skills and pedagogy. Therefore, there must be a balance between self-paced and instructor-paced learning. To ensure the optimal amount of flexibility, self-paced learning is preferable with the use of instructor-paced learning only when from a learning perspective it is needed to ensure the quality of learning. The materials needed for instructor-based learning heavily depend on the chosen delivery method.

Innovative delivery methods and learning materials

The use of innovative and engaging ways of delivering education and training should be promoted, because these new methods of delivering can help to improve the quality of learning. It can also attract learners that are not interested in the traditional way of knowledge transfer. All the new methods shift the centrality from the teacher or trainer to the learner, from the transmissive lesson to activities through which the learners construct their own knowledge and develop skills and competences. This also influences the role of learning materials. Traditionally study books and slide decks are the main learning materials, but new methods require other materials ranging from instructional videos and case assignments to guidelines on the boundaries of an assignment and educational games. Some examples of possible methods:

- **Flipped classroom:** The flipped classroom is a method aimed at increasing learner engagement, understanding and retention by reversing the traditional classroom teaching approach: learners receive learning materials— generally videos— before class which they should then study in advance so that the class time can be used for discussions and other active and collaborative activities.
- **Project-based learning:** This is a cooperative teaching-learning strategy. Project team members work on a complex topic according to a plan, and the result is a real product or a performance. This works best if the learners autonomously choose a project to be developed that responds to a real need for them or for others, or if they receive a real project task from a partner company. This method requires access to materials that inform learners about what they need to learn for the project, but not central materials are needed except for the assignment description.
- **Research-based learning or inquiry-based learning or discovery-based learning:** This cooperative teaching-learning strategy is based on the stimulus of learners' curiosity. Learners need to solve a real-life problem, form groups, ask questions, and find answers to questions. Learners build on their own knowledge based on information available from various sources. This approach helps students learn about hypothesis generation and testing. The emphasis is on discovering facts or developing a higher understanding of the topic. Again, also in this method only the assignment description is needed as pre-formulated learning material.
- **Gamification or game-based learning:** Game-based learning means learning achieved through the use of games or video games. Learning is stimulated by the characteristic aspects of the game: challenge, levels, achievement of objectives through scores and prizes. The game is the learning material, which is of course expensive to develop.

- **Peer learning:** In peer learning, learners help each other by providing feedback or support. It makes learning more flexible because learners are less dependent on instructors. It requires good guidelines and process rules to make sure that the peer learning is of sufficient quality.
- **Work-based learning environments:** learning providers and organisations should collaborate more closely to provide learners with real life experiences that enable them to obtain learning outcomes in a more effective way. This can be a full apprenticeship, but also just a one- or two-day practical assignment or execution of a task within the organisation. The focus is on the specific experience which does not require pre-set learning materials.

These are some examples of popular innovative ways of delivering training that all require different kinds of learning materials. It is important to realise that all of these methods require a mindset which is not sending information to learners, but working together with learners more in a coaching role and learning materials have a different role in these kinds of learning.

8.2 Strategic objective 4: Validate learning outcomes

It is important that learning is validated to establish whether somebody is an up-to-date software professional and that software professionals can showcase their competences and skills. This stimulates mobility of software professionals, increases the professionalism of the software services sector, and supports lifelong learning. It is also important that learning providers deliver good quality programmes so learners can trust that a learning programme leads to the relevant learning outcomes.

Assessments are the way to validate whether somebody achieved a learning outcome. The fact that the achievement of learning outcomes will be assessed according to agreed upon standards, means that it is possible to recognise the learning outcomes which promotes mobility.

Certification for example shown in the form of digital badges are a good way for professionals to showcase the skills and knowledge that they have proven by assessment. Certifications can be designed to be stackable even all the way to a complete qualification. A multi-level certification framework that directly connects to the unit learning outcomes, programme learning outcomes and even to complete roles, helps to recognise the competences and skills of software professionals.

A quality label can ensure that the assessments and the education and training leading up to the assessment of learning outcomes, are of good quality. Establishing a quality label for providers of education and training for software professionals will therefore increase recognition.

8.2.1 Design and implement a certification scheme for software professionals

People who successfully complete the assessment of a training or course can be certified for the obtaining of the related learning outcomes. This can be a stand-alone training or course, but they can also be part of a larger programme. There must be an assessment that proves whether the intended learning outcomes are achieved. This means that this does not include the well-known certificates of participation, because in that case there is no proof that the learning outcomes are achieved.

Traditionally, qualifications and certifications covered a lot of knowledge and skills that was validated at once. This has changed in the digital age. It is now possible, using tools like micro credentialling and digital badges, to recognise relatively small (parts of) skills and knowledge. These can even be linked to only ten minutes of learning material (microlearning) but are typically covering a bigger unit of learning (like e.g., 1 ECTS/ 25-30 hours of learning).

Certifications for skills of software professionals are important to gain recognition which enables for example mobility. The certifications can be showcased by professionals through the use of digital badges. The certification framework consists of several levels so a combination of badges on the level of the smallest unit will together lead to a higher-level badge and so on. This stacking of credentials could lead to the final level which is a badge indicating that somebody has acquired the competences related to a complete role profile which equals a traditional qualification.

A system of digital badges also prevents problems like the authentication of paper certificates. Professionals can learn a skill, obtain the learning outcomes proving this by assessment, and add this achievement to their digital resume in the form of a digital badge. The framework will also connect to the **European Digital Credentials for Learning** tool of [Europass](#)⁴⁵.

The certifications can be awarded using two pathways: the first is the recognition of professional certifications and the second is the recognition of micro-credentials.

The field of software services has a lot of professional vendor certifications and professional certifications offered by independent providers. These professional certifications are mapped against the certification framework, so it is clear which professional certificate covers which certificate of the framework. The recognition of these professional certifications leads to the awarding of credentials in the form of digital badges.

The second path is by recognition of micro-credentials issued by accredited partners. These are learning providers that have proven quality especially regarding the assessment of the obtainment of learning outcomes. They define learning units that lead to micro-certificates upon successful completion that are mapped against the certification framework in the same way as professional certifications are. The recognition of these micro-credentials leads again to the awarding of credentials in the form of digital badges.

8.2.2 Design and implement a quality label

A system focusing on learning outcomes instead of the learning itself will automatically have a focus on the quality of the assessment that verifies whether learning outcomes are obtained. A quality label that ensures that both issuers of professional certifications and learning providers issuing micro-credentials indeed can guarantee the quality of their assessment of learning outcomes.

⁴⁵ Europass, available at: <https://europa.eu/europass/en/european-digital-credentials-learning>

The quality of issuers of professional certification can be assessed by using the ISO/IEC 17024 standard for bodies operating schemes for the certification of persons as a starting point. The learning providers issuing micro-credentials can be assessed by using EQVET and ESG as a starting point with the limitation that these are still focussed on the learning process itself instead of the assessment of learning outcomes.

These inputs are used to develop a procedure that awards a quality label to issuers of professional certification and learning providers that ensures they will issue professionals certifications and micro-credentials in a correct way to those that proved via assessment that they obtained the related learning outcomes.

9 Strategic sectoral cooperation

The third strategic pillar is to forge sectoral cooperation to address software skills needs of the industrial ecosystem. In brief, this pillar is about raising awareness, cooperation, and engagement among the players with a stake in skilling software professionals. This section describes how to do that.

9.1 Strategic objective 5: Boost awareness

Raising awareness of the existing skills gaps in the software services sector and the importance of closing this gap is crucial for a successful software sector skills strategy. First and foremost, awareness drives engagement and cooperation from key stakeholders. Second, it increases the overall societal attention to software skills gaps. Third, high visibility can attract additional support and resources and facilitate the sharing of best practices. Therefore, we can only answer the lack of software professionals in the EU if people know about the software professional requirements, the labour market needs, and available education and training pathways.

This strategic objective consists of two overall actions. The primary action is to develop and implement a methodological communication strategy. This document serves as a comprehensive blueprint for enhancing visibility and reach, outlining communication strategies, tactics, and key messaging. The second action involves creating and maintaining the Software Skills Community, which provides stakeholders with a permanent space to raise awareness and disseminate information, resources, and best practices.

9.1.1 Develop and implement a communication strategy

The Communication Strategy is designed to reach the following goals:

- Raise awareness about value propositions towards key stakeholder groups.
- Disseminate information regarding how the sector tackles the need for skilling, reskilling, and upskilling the EU's workforce in line with the latest market requirements.
- Ensure the dissemination and adoption of the European Software Skills Strategy, vocational curricula, education and training programmes and certification framework, online-based learning platforms, and Software Skills Community.
- Promote Software as a career choice for young people and adults across Europe.

The Communication Strategy highlights a set of awareness-raising initiatives, which revolve around different campaigns. They fall into two categories: stakeholder-specific campaigns and general campaigns. The former targets the three primary stakeholder groups: potential learners, education and training providers, and organisations in search of software skills. These campaigns aim to drive engagement among these stakeholders. Conversely, the general campaigns target primary and secondary stakeholders alike and seek to raise general awareness about the skilling activities, milestones, and results. The main communication tools to be used for these campaigns' dissemination and outreach activities are websites, social media accounts (X and LinkedIn), mailing and newsletters, press releases, online and on-site events, webinars, and visual assets. A communication package is developed before the rollout of each campaign. It supports partners' outreach activities by outlining concrete directions, messages, tools and channels, and timelines.

Campaign	Audience	Objective
General campaigns		
Website and social media launch	All target audiences	<ul style="list-style-type: none"> ● Launch communication channels. ● Invite stakeholders to discover websites and follow accounts on social media.
Raise awareness of skills gaps	All target audiences	<ul style="list-style-type: none"> ● Use communication channels to inform about the skills gaps and the need to close these.
Raise awareness of solutions to skills gaps.	All target audiences	<ul style="list-style-type: none"> ● Promote learning programmes. ● Invite stakeholders to join events and conferences.
Stakeholder-specific campaigns		
Promote learning programmes and software as a career choice	Potential learners	<ul style="list-style-type: none"> ● Promote software as a career choice. ● Increase the interest in software learning programmes. ● Provide practical career guidance for students, young professionals, career changers, and job seekers.
Promote the online-based learning platform and train-the-trainers programmes	Potential learners, education and training providers, and organisations in search of software skills.	<ul style="list-style-type: none"> ● Public launch of the learning programmes and materials through an online-based platform for direct uptake by education and learning providers and independent learners. ● Promote widespread adoption of the curricula, learning programmes, and qualifications among educational providers and organisations with software needs across Europe, creating a

		high supply of potential candidates and ensuring employers will recruit workers into the desired roles.
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Figure 16. Table: Types of campaigns to raise awareness of software skills gaps and activities to remedy these.

9.1.2 Build and maintain a software online community

The Software Skills Community is an online social media platform that allows stakeholders to:

- Share knowledge, insights resources, and good practices.
- Mobilise influencers and tech leaders to advocate for software professional quality, and drive interest in software-related careers.
- Draw attention to the attractiveness of software-related roles and learning pathways.
- Provide a place for feedback and guidance on the use of learning programmes and curricula.
- Identify trends and market needs.

The Community is open and accessible to all organisations and individuals, but primarily targets:

- Education and training providers
- Validation providers
- Tech-driven organisations
- Employment services
- Policymakers
- Current and future software professionals.

The community was successfully launched on 17 October 2022. Through general campaigns to raise awareness, stakeholders are invited to join and be active members of the Software Skills Community. To ensure the sustainable growth of the community, a **Community Deployment Roadmap** indicates the actions at each stage of development for optimal impact.

The success of this community heavily depends on the active involvement of its members and the overall user base. To capitalize on this, the strategy leverages platforms already widely used by the target groups. Consequently, the community is centred around one main tool – a [LinkedIn Group](#). Various tools, such as newsletters, social media, and events, are employed to support the community's growth. The Community is planned to develop through three key phases: the inception phase, the establishment phase, and the maturity phase.

9.2 Strategic objective 6. Foster cooperation

While awareness allows stakeholders to get involved, a sectoral approach to addressing software skills must also ensure robust cooperation and collaborative synergy among these engaged parties. The objectives of this collaboration are to continuously research, identify and analyse the skills requirements of the European software sector and develop innovative learning programmes that will address the sector's short-, medium-, and long-term needs.

This section highlights three mechanisms to foster cooperation. First, the Alliance represents a formal and expanding collaborative network of stakeholders who can offer valuable contributions towards addressing the critical gaps in software skills. Second, the learning programmes build on and align with European standards and framework, creating a common language and understanding between stakeholders and ensuring that the learning programmes are recognised and valued across the industry. Third, the mobility programmes facilitate transnational course and curriculum collaboration partnerships.

9.2.1 Build and foster a software sector alliance

The Alliance serves as a formal hub for exchanging ideas, resources, and strategies, fostering a unified approach to enhancing software expertise at a European level. Therefore, it acts as a vehicle for continuously advancing solutions to skills needs. The Alliance fosters collaboration among its members through a carefully structured set of activities, ensuring that its members remain closely connected and effectively collaborate. These activities include:

- **Annual Programme of Meetings:** The Alliance organizes an annual programme featuring online and offline meetings. These gatherings facilitate networking and collaboration among partners and provide regular opportunities for interaction and exchange of ideas.
- **Online Networking and Collaboration:** Beyond physical meetings, the Alliance maintains active online engagement through private discussion groups and video calls. The continuous digital interactions enable members to collaborate and communicate effectively, irrespective of their geographical locations.
- **A Programme of Events:** To engage the wider software sector stakeholder group, the Alliance organizes various events, including online events and Stakeholder Conferences, which would serve as a pivotal forum for individuals and organizations interested in software skills to come together, share information, and collaboratively shape a shared vision for ongoing development in the area of software skills

The long-term impact of the Alliance is largely determined by its ability to encompass a wide range of key stakeholders. Therefore, it welcomes public and private organisations of all sizes, different types of learning providers, accreditation and certification bodies, social partners, chambers of commerce, and other associations. A strategic plan has been implemented for the Alliance's ongoing expansion. This strategy involves encouraging partners to extend invitations to stakeholders within their networks, utilizing the Alliance's communications channels to attract new members, and initiating targeted campaigns to broaden the Alliance's reach.

A second way to maintain a long-term alliance is to collaborate with existing initiatives, as it broadens access to resources, enhances impact and innovation, and strengthens adaptability. The EU Pact for

Skills is key in this regard.⁴⁶ The Pact aims to support public and private organisations with upskilling and reskilling. By being a member of the Pact for Skills, the Alliance is able to tap into knowledge on upskilling and reskilling skills, receive guidance on funding opportunities, and establish partnerships with our members of this community. The Alliance also participates in and collaborates with other related initiatives (Skills Year, etc.) and projects (ARISA, CHAISE, DS4Skills, etc.).

Third, the Alliance will seek funding opportunities to expand and scale up activities. Relevant funding opportunities include regional and national calls and Erasmus+ KA2 Actions.

9.2.2 Connect to European standards and initiatives

A key purpose of European alliances for sectoral cooperation on skills is to use relevant European standards and classifications.⁴⁷ Using these enable cooperation by creating a common language around software roles, competences, and skills. This facilitates the development of curricula and the creation of recognisable learning programmes with broad support across the wider European community. Various standards and classifications are relevant in this regard, notably e-CF, European ICT Professionals Role Profiles, ESG and EQAVET, and ESCO.

e-CF

The [EN 16234-1 e-Competence Framework \(e-CF\)](#)⁴⁸ is a European neutral standard that specifies ICT competences, developed and maintained through an EU-wide balanced multi-stakeholder agreement process under the European Committee for Standardization. The standard is also a key component of the European Digital Agenda for ICT Professionalism and an important source for developing ESCO.⁴⁹ The e-Competence Framework (e-CF) (EN 16234-1) identifies 41 competences related to the ICT professional field, providing guidance on which competences should be covered by the software learning programmes.

Being closely related to e-CF, the European standards [Foundational Body of Knowledge for the ICT profession](#)⁵⁰ (ICT BoK) and the [Guidelines for developing ICT Professional Curricula](#)⁵¹ also play a role in developing and maintaining educational profiles, curricula, and learning programmes.

European ICT Professional Role Profiles

⁴⁶ https://pact-for-skills.ec.europa.eu/index_en

⁴⁷ <https://ec.europa.eu/social/main.jsp?catId=1415&langId=en>

⁴⁸ General information about the e-CF, available at ITPE: <https://itprofessionalism.org/about-it-professionalism/competences/the-e-competence-framework/> Formal information, available at CEN & CENELEC: https://standards.cencenelec.eu/dyn/www/f?p=205:110:0:::FSP_PROJECT:67073&cs=15E62ED24D608A5F10D6BEE8E6D50FA10

⁴⁹ <https://esco.ec.europa.eu/en/about-esco/escopedia/escopedia/european-e-competence-framework-e-cf>

⁵⁰ CEN/TC 428 (2022) ICT BoK (EN 17748), available at: https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0:::FSP_PROJECT,FSP_ORG_ID:71369,1218399&cs=1037FF415D2B146EA5B76090895FB7FDD

⁵¹ CEN/TC428 (2022) Guidelines for developing ICT Professional Curricula (TS 17699), available at: https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0:::FSP_PROJECT,FSP_ORG_ID:72363,1218399&cs=169E9940F2911D404FAE0D4872E5D2630

Relevant software roles can be selected from the [CEN/CWA 16458-1 European ICT Professionals Role Profiles](#),⁵² which is a European standard that outlines the role profiles for ICT professionals. The competences of each of the 30 ICT Professional Role Profiles are based on e-CF and provide a generic set of typical roles performed by ICT Professionals in any organisation. The profiles are meant to be “a flexible tool for ICT professional development and profile construction. They are not intended to represent a rigid standard. The role profiles were built as a foundation and inspiration, for the flexible creation of more context-specific profiles in a broad variety of areas.”⁵³

ESG and EQAVET

The ESG (European Standards and Guidelines for Quality Assurance in Higher Education) and EQAVET (European Quality Assurance in Vocational Education and Training) were created to ensure and improve the quality of education in Europe. ESG focuses on higher education, while EQAVET is specific to vocational education and training. As the relevant education and training providers of software skills include both higher education institutions and (private) VET providers, quality assurance should draw upon both frameworks to ensure the quality of software learning programmes.

ESCO

The [European Skills, Competences, Qualifications and Occupations \(ESCO\)](#)⁵⁴ provides a standardised terminology and reference for skills, competences, and qualifications across EU member states. It also systematically shows the relationships between the different concepts. Rather than using ESCO as a source, software skills analysis can provide input to ESCO by highlighting sectoral market developments concerning skills and needs.

9.2.3 Develop and implement a European software sector mobility programme

Building learning programmes on international standards and European recognition promotes mobility. “Mobility,” in this regard, refers to transnational curriculum partnerships and the movement of students and educators across different countries for international learning experiences. The mobility programmes are a third way to strengthen sectoral cooperation. There are two levels of mobility:

- Short-term mobility: Short-term mobility focuses on virtual or temporary cross-border interactions. That enables students and educators to participate in mobility activities for a brief period, often without the need to travel. As such, short-term mobility offers several advantages, including low costs for participants and a more flexible form of mobility that allows education

⁵² CEN/CWA 16458-1 (2018) European ICT Professionals Role Profiles, available at: <https://itprofessionalism.org/about-it-professionalism/competences/where-to-buy-the-e-cf-standard/>

⁵³ European Committee for Standardization, “European ICT Professional Role Profiles,” CEN WORKSHOP AGREEMENT, August 2018, 5, https://www.cenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN%20sectors/Digital%20Society/CWA%20Download%20Area/ICT_SkillsWS/16458-1.pdf.

⁵⁴ ESCO, available at: <https://esco.ec.europa.eu/select-language?destination=/node/1>

and training providers to engage in small-scale collaborative efforts with the possibility of later establishing long-term mobility.

Examples of short-term mobility initiatives include online or offline guest lectures, students from different countries working together on projects, and summer schools.

- Long-term mobility: Long-term mobility entails extended stays at a foreign education and training provider, usually for several months to a year. It typically involves participating in courses, research, or teaching at the host institution. Consequently, long-term mobility offers opportunities for deeper and more enduring cooperation.

Examples of long-term mobility initiatives include student exchange with recognition of education and longer guest lectureships.

10 Conclusions

The conclusions are organised to point out some conclusive ideas from each of the six strategic objectives that provide structure to this Software Skills Strategy.

SKILLS AND ROLES

Strategic objective 1. Monitor and analyse skills needs. The first strategic objective focuses on distinguishing the right skills for software professionals. To identify the urgent and emerging skills needs for software professionals, research was conducted using different data collection techniques and different target groups (see ESSA Needs Analysis). A key finding is that the skills needed in software roles and jobs are certainly not limited to hard skills, like programming, but include also broader profession-related skills, like project management and soft skills, like communication and teamwork. These skills are found to be highly relevant to all the roles that software professionals fulfil. This finding is confirmed by a strategy review process, an iterative monitoring cycle focused on the demand for skills, roles and education held on a yearly basis. An important element of this process is the involvement of experts by means of expert groups, organised at national levels and at European level.

Strategic objective 2. Monitor and analyse market-oriented software roles. Besides skills, also the roles for which software professionals are trained and educated must meet market demands. To define relevant software roles, the European framework of ICT professional role profiles was used (CWA 16458) and mapped against roles listed in the ESCO classification. Five of these profiles were selected that could be classified as software professional in the context of this Strategy: developer, DevOps expert, solution designer, test specialist, and technical (software) specialist. These five selected role profiles were expanded with a set of broader profession-related and soft skills besides key hard skills, because the research showed an urgent need for software professionals that possess the skills to work together with other disciplines, hence T-shaped and π -shaped professionals.

EDUCATION AND TRAINING

Strategic objective 3. Design and develop harmonised curricula. The competences, skills, and knowledge required to succeed in a software professional role are translated into measurable learning outcomes. A set of nine educational profiles was developed to cover the five software roles at different qualification levels — ranging from EQF 4/5 to EQF 7 and aligned with the e-CF, the European standard that describes competences for ICT professionals at different levels. These profiles can be used to create flexible and modular learning programmes that enable individualised pathways and recognition of earlier acquired skills and competences. They also facilitate the comparison of curricula and learning programmes between different institutes and between countries, enhancing the mobility of students, learners and professionals.

Strategic objective 4. Validate learning outcomes. It is important that learning is validated to establish whether somebody is an up-to-date software professional and that software professionals can showcase their competences and skills. Assessments are the way to validate whether somebody achieved a learning outcome. An independent system of vendor-neutral assessment of learning outcomes should be created. Two actions are needed: Firstly, the design of a certification framework for skills of software professionals, based on the principles of micro credentialling and making use of

digital badges and secondly, a quality label for learning providers ensuring that their assessments, education and training are of good quality.

STRATEGIC SECTORAL COOPERATION

Strategic objective 5. Boost awareness and stakeholder engagement. The strategy's success largely hinges on effectively utilizing communication tools to foster awareness and engagement. This involves two key strategic actions. Firstly, creating an engaging communication plan to activate key stakeholders and increase societal awareness about the need for software skills and solutions to address this gap. Secondly, establishing an online Software Skills Community will serve as a dynamic platform for stakeholders to share information, resources, and best practices. This initiative aims to be more than just a platform; it's a catalyst for innovation in the software skills domain.

Strategic objective 6. Foster cooperation and ensure sustainability. The sixth strategic objective is to establish and nurture long-term cooperation between stakeholders, which is imperative for the continuous development of relevant and market-oriented learning programmes and learning innovations. Core to that objective is the creation of an Alliance as a formal hub for exchanging ideas and strategies, hosting regular meetings and events for stakeholder engagement, and collaborating with related initiatives. Additionally, the strategy involves aligning learning programmes with European standards to create a common language and European-wide recognition of learning outcomes and certifications. Thirdly, cooperation is fostered through mobility initiatives, whereby students and educators move across different countries.

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12 Annexes

Annex 1: Strategic objectives and available resources

SKILLS AND ROLES	
Strategic Objective	ESSA Deliverables
1. Monitor and analyse skills needs	
1.1 Identify urgent skills needs for software professionals	<ul style="list-style-type: none"> • D.4. Needs Analysis Report - Europe's Most Needed Software Roles and Skills • D.6. Software Skills Strategy Review Process
1.2 Identify emerging skills needs for software professionals	<ul style="list-style-type: none"> • D.4. Needs Analysis Report - Europe's Most Needed Software Roles and Skills • D.6. Software Skills Strategy Review Process
2. Monitor and analyse market-oriented software roles	
2.2 Monitor developments in existing software related roles	<ul style="list-style-type: none"> • D.4. Needs Analysis Report - Europe's Most Needed Software Roles and Skills • ESSA Booklet Software Professional Role Profiles • D.6. Software Skills Strategy Review Process
2.3 Identify emerging software related roles	<ul style="list-style-type: none"> • D.4. Needs Analysis Report - Europe's Most Needed Software Roles and Skills • D.6. Software Skills Strategy Review Process
EDUCATION AND TRAINING	
Strategic Objective	ESSA Deliverables
3. Design and develop harmonised curricula	
3.1 Develop and maintain European educational profiles for software roles	<ul style="list-style-type: none"> • ESSA Educational Profiles for Software Roles + Infographic

3.2 Design curricula and implement learning programmes tailored for specific contexts	<ul style="list-style-type: none"> • D.7. Software Skills Curricula • D.11. Learning programme pilots • D.12. Work-based learning component • D.13. Train-the-trainer programme • Booklet - 12 Ideas to tackle the shortage of software professionals in Europe - Case studies
3.3 Develop and maintain learning materials	<ul style="list-style-type: none"> • D.10. ESSA Learning Programmes and Materials
4. Validate learning outcomes	
4.1 Design and implement a certification scheme for software professionals	<ul style="list-style-type: none"> • D.8. Qualification & Certification Framework
4.2 Design and implement a quality label for learning providers	<ul style="list-style-type: none"> • D.20. Accreditation Standards and Criteria
STRATEGIC SECTORAL COOPERATION	
Strategic Objective	ESSA Deliverables
5. Boost awareness	
5.1 Develop and implement a communication strategy	<ul style="list-style-type: none"> • D.14. Communication Strategy and Tools • Media Kit Associated Partners • D.19. Demand Generation for Software Careers
5.2 Build and maintain a software online community	<ul style="list-style-type: none"> • D.15. Project Website and Online Collaboration Platform • Community Deployment Roadmap
6. Foster cooperation	
6.1 Build and foster a software sector alliance	<ul style="list-style-type: none"> • D.21. Long Term Sustainability Strategy • D.17 European Software Skills Stakeholder Conference • D.18 EU Dissemination & Rollout
6.2 Connect to European standards and initiatives	<ul style="list-style-type: none"> • D.21. Long Term Sustainability Strategy

<p>6.3 Develop and implement a European software sector mobility programme</p>	<ul style="list-style-type: none">• D.9. European Mobility Programme
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Annex 2: ESSA role profiles vs ESCO occupations

ESSA Role profiles for software roles <i>(based on CEN ICT Professional Role Profiles)</i>	ESCO related occupations <i>(ESCO dataset – v1.1.1)</i>
<p style="text-align: center;">Solution designer</p>	<ul style="list-style-type: none"> • ICT application configurator • Instructional designer • Digital games designer • Software analyst • Software architect
<p style="text-align: center;">Developer</p>	<ul style="list-style-type: none"> • Software developer • ICT application developer • Applications programmer • ICT system developer • Embedded systems software developer • Mobile app developer • Industrial mobile devices software developer • User interface developer • Digital games developer
<p style="text-align: center;">Technical (software) specialist</p>	<ul style="list-style-type: none"> • ICT operation technician • ICT technician
<p style="text-align: center;">Test specialist</p>	<ul style="list-style-type: none"> • ICT system tester • Software tester • ICT integration tester • Digital games tester • ICT usability tester • ICT accessibility tester • ICT test analyst
<p style="text-align: center;">DevOps expert</p>	<p><i>n.a.</i> DevOps is considered knowledge and not a separate occupational profile in ESCO</p>

Annex 3: Glossary

This glossary provides a list of key terms that are used hereinafter and their definitions. It is not meant to provide an exhaustive list of all the terms related to the subject of this study.

Term	Definition
Accreditation of an education or training programme	Process of quality assurance through which a programme of education or training is officially recognised and approved by the relevant legislative or professional authorities following assessment against predetermined standards. (Cedefop, 2014)
Accreditation of an education or training provider	Process of quality assurance through which an education or an education training provider is officially recognised and approved by the relevant legislative or professional authorities following assessment against predetermined standards. (Cedefop, 2014)
Assessment (of learning outcomes)	Process of appraising knowledge, know-how, skills and/or competences of an individual against predefined criteria (learning expectations, measurement of learning outcomes). Assessment is typically followed by certification. (Cedefop, 2014)
Associate degree	Qualification awarded after successful completion of the so-called short cycle in the Qualifications Framework of the European Higher Education Area (EQF). The short cycle fits within or is linked to the first cycle (or bachelor's level). The degree requires approximately 120 ECTS credits. (European Consortium for Accreditation, 2021)
Bachelor's degree	Qualification awarded after successful completion of the first cycle in the Qualifications Framework of the European Higher Education Area (EQF). The degree usually requires a minimum of 180 and a maximum of 240 ECTS. (European Consortium for Accreditation, 2021)
Certification (of learning outcomes)	Process of issuing a certificate, diploma or title formally of learning outcomes attesting that a set of learning outcomes (knowledge, knowhow, skills and/or competences) acquired by an individual have been assessed by a competent body against a predefined standard. (Cedefop, 2014)
Comb-shaped professionals	Professionals who have a depth of knowledge and skills in many specific domains of expertise or fields (all the vertical bars of the comb-shape) and have broad knowledge and skills across multiple fields or disciplines (the horizontal bar of the comb-shape). that allows them to cross collaborate and effectively leverage someone else's expertise in that area. (Adapted from Friedlein, 2013; Grupman, J., 2 021)
Curriculum	Inventory of activities related to the design, organisation and planning of an education or training action, including definition of learning objectives, content, methods (including assessment) and material, as well as arrangements for training teachers and trainers. (Cedefop, 2014)

Competence	Demonstrated ability to apply knowledge, skills, and attitudes for achieving observable results. (CEN/TC 428, EN 16234-1 (2019))
DevOps	Development methodology aimed at bridging the gap between Development (Dev) and Operations (Ops), emphasizing communication and collaboration, continuous integration, quality assurance, and delivery with automated deployment utilizing a set of development practices. (Jabbari et al., 2016)
Digital badge	Validated indicator of accomplishment, skill or competences, that can be displayed, accessed, and verified online, which describes a specific performance that the recipient has done to earn it. They often represent the completion of a microcredential. (Carey, 2012)
Doctorate degree	Qualification awarded after successful completion of the third cycle in the Qualifications Framework of the European Higher Education Area (EQF). The degree usually requires a three to four years of study, mostly as a period of research. (European Consortium for Accreditation, 2021)
e-Competence Framework (e-CF)	Standard established as a tool to support mutual understanding and provide transparency of language through the articulation of competences required and deployed by Information and Communication Technology (ICT) professionals. (CEN/TC 428, EN 16234, 2019)
Educational credential	Documented statement that acknowledges a person's learning outcomes. (European Micro-Credential Terminology, 2022)
Educational profile	Structure that enables a competence-oriented learning programme design and development, thus providing a link between competences needed in a professional environment and learning outcomes of education and training. It assists planning education and professional accomplishment at individual and institutional levels. (CEN/TC 428, TS 17699, 2021)
E-shaped professionals	Professionals who have a depth of knowledge and skills in a specific domain or field (expertise) and also have broad knowledge and skills across multiple fields or disciplines (experience), which enables them to collaborate across disciplines with experts in other areas. Besides expertise and experience these professionals also possess knowledge and skills related to the tangible (execution) and intangible (exploration), implying having both a big-picture outlook and an attention to detail from being a practitioner. (Adapted from DaVanzo, 2010)
European Qualification Framework (EQF)	Overarching framework that makes transparent the relationship between European national (higher) education frameworks of qualifications and the qualifications they contain. It is an articulation mechanism between national frameworks. (Bologna Working Group on Qualifications Frameworks, 2005)

<p>European Skills, Competences, Qualifications and Occupations (ESCO)</p>	<p>The multilingual ESCO classification identifies and categorises skills, competences, qualifications, and occupations relevant for the EU labour market and education and training. It systematically shows the relationships between the different concepts. (ESCO, 2022)</p>
<p>Formal education</p>	<p>Education that is institutionalised, intentional and planned through public organizations and recognised private bodies [...] Formal education programmes are thus recognised as such by the relevant national education or equivalent authorities Institutionalised education occurs when an organization provides structured educational arrangements, such as student-teacher relationships and/or interactions, that are specially designed for education and learning. [...] Formal education consists mostly of initial education. Vocational education, special needs education and some parts of adult education are often recognised as being part of the formal education system. [...] Programmes that take place partly in the workplace may also be considered formal education if they lead to a qualification that is recognised by national education authorities (or equivalent). These programmes are often provided in cooperation between educational institutions and employers (e.g. apprenticeships). (UNESCO, 2011)</p>
<p>Formal learning</p>	<p>Learning that occurs in an organised and structured environment (such as in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner's point of view. It typically leads to certification. (Cedefop, 2014)</p>
<p>Formal recognition (of learning outcomes)</p>	<p>Process of granting official status to learning outcomes knowledge, skills and competences either through:</p> <ul style="list-style-type: none"> · validation of non-formal and informal learning; · grant of equivalence, credit units or waivers; · award of qualifications (certificates, diploma or titles). (Cedefop, 2014)
<p>Hard skills</p>	<p>Strictly job-specific, closely connected with knowledge, easily observed, measured and trained skills. They constitute the core occupational requirements of a job. (Dall'Amico, E. & Verona, S., 2015)</p>
<p>Higher or upper VET</p>	<p>Composed of: a) post-secondary level VET, offered outside higher education; b) higher-level continuing VET (CVET) offered within or outside the formal education system (usually after entry into working life); qualification here often gives access to nationally recognised qualifications but the target is adult learners; qualifications are often based on professional experience and examinations (competence tests); c) higher-level CVET provided outside the formal education system (by adult education centres, public employment services or private companies), which do not fall into the above categories. Higher VET relates to EQF levels 5 to 8. (Cedefop, 2019)</p>
<p>ICT Body of Knowledge (ICT BoK)</p>	<p>Structured set of information including, terminology, concepts, models, and theories which represent the accepted and agreed upon core knowledge base required by the ICT profession. (CEN/TC 428, EN 17748-1, 2022)</p>

ICT Professional Role Profiles	These profiles reflect a collection of typical tasks, competences and responsibilities that are to be fulfilled and each profile is given a common use title for ease of identification. They provide a broad picture of the activities performed by individuals engaged in the multitude of positions that make up the ICT profession. ICT Professional Role Profiles are key components of ICT jobs. (CEN Workshop Agreement 16458, 2018)
ICT sector	Combination of manufacturing and services industries whose products primarily fulfil or enable the function of information processing and communication by electronic means, including transmission and display. OECD (2022)
Informal learning	Learning resulting from daily activities related to work, family or leisure. It is not organised or structured in terms of objectives, time or learning support. Informal learning is in most cases unintentional from the learner's perspective. Informal learning outcomes may be validated and certified; Informal learning is also referred to as experiential or incidental/random learning. (Cedefop, 2014)
Information and Communication Technology (ICT)	Diverse set of technological tools and resources used to transmit, store, create, share or exchange information. (UNESCO, 2009)
Initial education	Formal education of individuals before their first entrance to the labour market, i.e., when they will normally be in full-time education. It thus targets individuals who are regarded as children, youth, and young adults by the society to which they belong. It is typically provided by educational institutions in a continuous educational pathway. (UNESCO, 2012)
International Standard Classification of Education (ISCED)	Global reference classification for education systems and it provides a comprehensive framework for organising education programmes and qualification by applying uniform and internationally agreed definitions to facilitate comparisons of education systems across countries. (ISCED, 2022)
Knowledge	Theoretical or practical understanding and awareness of phenomena such as facts, terminology, concepts, models, or theories that are related to a field of work or study. Knowledge is the outcome of the assimilation of information through learning and is theoretical and/or factual. (CEN/TC 428 EN 17748-1, 2022; Council of the European Union, 2017)
Learning	Process by which an individual assimilates information, ideas and values and thus acquires knowledge, know-how, skills and/or competences. Learning occurs through personal reflection, reconstruction and social interaction. It may take place in formal, non-formal or informal settings. (Cedefop, 2014)
Learning environment	Any environment that allows a person to learn in providing certain conditions or procedures to do so; this can be an educational institute, a training facility or a workplace, as well as a face-to-face, hybrid or a virtual environment. (CEN/TC 428, TS 17699, 2022)

Learning outcome	Statements of what a learner knows, understands and is able to do on completion of learning process, which are defined in terms of knowledge, skills and competence. (Cedefop, 2014)
Learning programme	Inventory of activities, content and/or methods implemented to education or training achieve education or training objectives (acquiring knowledge, skills and/or competences), organised in a logical sequence over a specified period of time. (Cedefop, 2014)
Learning path	Specific route that reflects a person's subsequent learning activities undertaken in a specific learning environment throughout his/her life, career or study. (CEN/TC 428, TS 17699, 2022)
Lifelong learning	All learning activity undertaken throughout life, with the aim of improving knowledge, skills/competences and/or qualifications for personal, social and/or professional reasons. (Cedefop, 2014)
Master's degree	Qualification awarded after successful completion of the second cycle in the Qualifications Framework of the European Higher Education Area (EQF). The degree usually requires a minimum of 90 ECTS, of which at least 60 ECTS at master's level. (European Consortium for Accreditation, 2021)
Microcredentials	Sub-unit of a credential that could accumulate into a larger credential or degree or be part of a portfolio. Microcredentials are frequently portrayed and promoted as a new way for individuals to build their own skills profile (portfolio) by collecting and "stacking" learning in flexible ways, at their own pace and according to their own priorities. Micro-credentials certify the learning outcomes of short-term learning experiences, for example a short course or training. They offer a flexible, targeted way to help people develop the knowledge, skills and competences they need for their personal and professional development. (European Micro-Credential Terminology, 2022; Cedefop, 2021 & European Approach to Micro-Credentials, 2022)
Modular programmes	Programmes that are composed of small discrete modules or learning units that are virtually self-contained, independent, nonsequential, and typically short in duration. Modular programmes allow students to compose the content of their education in a flexible way by combining different courses or modules. (French, 2015; UNESCO, 2011)
Non-formal education	Education that is institutionalised, intentional and planned by an education provider. [...] It is an addition, alternative and/or complement to formal education within the process of lifelong learning of individuals. [...] It caters to people of all ages but does not necessarily apply a continuous pathway structure; it may be short in duration and/or low-intensity; and it is typically provided in the form of short courses, workshops or seminars. Non-formal education mostly leads to qualifications that are not recognised as formal or equivalent to formal qualifications by the relevant national or sub-national education authorities or to no qualifications at all. Nevertheless, formal, recognised qualifications may be obtained through exclusive participation in specific non-formal education programmes; this often happens when the non-formal programme completes the competences obtained in another context. (UNESCO, 2011)

Non-formal learning	Learning which is embedded in planned activities not explicitly designated as learning (in terms of learning objectives, learning time or learning support), but which contain an important learning element. Non-formal learning is intentional from the learner's point of view. It typically does not lead to certification. (Cedefop, 2014)
Post-secondary, non-tertiary education	Encompasses qualifications that are considered to be beyond secondary education but are not included in the tertiary sector. Post-secondary non-tertiary education provides learning experiences building on secondary education, preparing for labour market entry as well as tertiary education. Students entering will have usually completed upper secondary education. Programmes usually have a full-time equivalent duration of between 6 months and 2 years. Post-secondary, non-tertiary education relates to EQF levels 4 and 5 and ISCED level 4. (UNESCO, 2011)
Prior learning	The knowledge, know-how and/or competences acquired through previously unrecognised training or experience. (Cedefop, 2014)
Profession-related skills	Skills that are necessary to fulfil professional tasks and are relevant for a broader range of different roles related to a certain profession. They are not related solely to one specific role. (ESSA Consortium, 2022)
Qualification	An official record (certificate, diploma) of achievement which recognises successful completion of education or training, or satisfactory performance in a test or examination; and/or the requirements for an individual to enter, or progress within an occupation. (UNESCO, 1984)
Qualification system	<p>All activities related to the recognition of learning outcomes and other mechanisms that link education and training to the labour market and civil society. These activities include:</p> <ul style="list-style-type: none"> • definition of qualification policy, training design and implementation, institutional arrangements, funding, quality assurance; • assessment and certification of learning outcomes. <p>Comment: a national qualifications system may be composed of several subsystems and may include a national qualifications framework. (Cedefop, 2014)</p>
Reskilling	Training enabling individuals to acquire new skills and knowledge giving access either to a new occupation or to new professional activities. (Cedefop, 2014)
Short cycle tertiary education	Programmes at this level are often designed to provide participants with professional knowledge, skills, and competences. Typically, they are practically based, occupational-specific and prepare students to enter the labour market. However, these programmes may also provide a pathway to other tertiary education. programmes. Short cycle tertiary education relates to EQF level 5 and ISCED level 5. (UNESCO, 2011).

Skilling	Training enabling individuals to acquire new skills and knowledge giving access either to an occupation or to professional activities. (Cedefop, 2014).
Skills	Ability to apply knowledge and use know-how to complete tasks and solve problems. Skills can be cognitive (involving the use of logical, intuitive, and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). (Council of the European Union, 2017)
Skills for software professionals	Skills necessary to perform tasks that lead to the design, development, deployment and/or maintaining of software. They can be grouped in hard, profession related and soft skills. (ESSA Consortium, 2022).
Skills gap	Situation where an individual does not have the kind and/or level of skills required to perform their job adequately. (Cedefop, 2014).
Soft skills	Patterns of thought, feelings and behaviours that are socially determined and can be developed throughout the lifetime to produce value. These are cross-cutting skills across jobs roles and sectors that relate to personal competences (confidence, discipline, self-management) and social competences (teamwork, communication, emotional intelligence). (Borghans, 2008; Dall'Amico, E. & Verona, S., 2015).
Software	Computer programs, procedures, and possibly associated documentation and data pertaining to the operation of a computer system (IEEE 828, 2012).
T-shaped professionals	Professionals who have a depth of knowledge and skills in a specific domain or field (the vertical bar on the letter T) and also have broad knowledge and skills across multiple fields or disciplines (the horizontal bar on the letter T), which enables them to collaborate across disciplines with experts in other areas. (Adapted from Gardner, 2017; Brown, 2009).
Tertiary education	Third level education that encompasses bachelor, master and doctorates or equivalents. Vocationally oriented education and training at tertiary qualifications level means education and training that can contain aspects of both academic and vocational areas typically with the majority of vocational aspects (e.g., Universities of applied sciences, Polytechnic institutes). It is usually located at levels equivalent to EQF levels 6 to 8 and ISCED levels 6 to 8. (Cedefop, 2011)
Transferable skills	Skills learned in one context that are useful for another. They can serve as a bridge from study to work and from one career to another, as they enable subject and research-related skills to be applied and developed effectively in different work environments. (European Science Foundation, 2009).
Upper-secondary education	Encompasses educational institutions that focus on general or vocational education. Programmes at this level are typically designed to complete secondary education in preparation for tertiary education, or to provide skills relevant to employment, or both. Pupils

	enter this level typically between ages 14 and 16. Upper secondary education relates to EQF levels 3 to 5 and ISCED level 3. (Cedefop, 2014;2020).
Upskilling	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. (Cedefop, 2014).
Validation (of learning outcomes)	Confirmation by a competent body that learning outcomes (knowledge, skills and/or competences) acquired by an individual in a formal, non-formal or informal setting have been assessed against predefined criteria and are compliant with the requirements of a validation standard. Validation typically leads to certification. (Cedefop, 2014).
Vocational Education and Training (VET)	Education and training which aims to equip people with knowledge, know-hows, skills and/or competences required in particular occupations or more broadly on the labour market. Vocational Education and Training covers upper-secondary, post-secondary, non-tertiary, and tertiary levels of education. (Cedefop, 2008; Erasmus+ Programme Guide, 2019).
Work-based learning	Learning that takes place through some combination of observing, undertaking, and reflecting on productive work in real workplaces. It may be paid or unpaid and includes a diversity of arrangements like apprenticeships, dual programmes, traineeships, internships, job shadowing, and other work placements used as part of school-based VET programmes. (OECD, 2016; UNESCO, 2015).
π-shaped professionals	Professionals who have a depth of knowledge and skills in two specific domains or fields (the two vertical bars of the π-shape) and have broad knowledge and skills across multiple fields or disciplines (the horizontal bar of the π-shape), which enables them to bridge the gap between the two domains or fields and also to collaborate with experts in other areas. (Adapted from Friedlein, 2013).