European Software
Skills Alliance.

A Software Skills Strategy for Europe.

HOW TO BRIDGE THE SOFTWARE SKILLS GAP
WITH TRAINING, EDUCATION, AND VALIDATION

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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 Vocational Education and Training 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 composed of 21 partners and 5 associated partners from the academic and non-academic sectors involved in the education, training and software sectors.

Full partners

Adecco Formazione, AICA, AKMI, AMETIC, ASIIN Consult, BCS Training, Budapest University of Technology and Economics, Codecool, DIGITALEUROPE, Digital Technology Skills, Global Knowledge France, Global Knowledge Netherlands, Chamber of Commerce and Industry of Slovenia, Hellenic Open University, HU University of Applied Sciences Utrecht, Irish Computer Society, IVSZ, MODIS, UNINFO, University of Ljubljana, and Warsaw School of Computer Science.

Associated partners

Amazon Web Services, European Schoolnet, General Assembly, IT Professionalism Europe, and NVIDIA Deep Learning Institute.

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List of abbreviations and acronyms

Abbreviation and acronyms	Description
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
HTML	Hypertext Markup Language
ICT	Information and Communication Technology
ICT BoK	ICT Foundational Body of Knowledge
IRTE	European Parliament's Committee on Industry, Research and Energy
IT	Information Technology
LOs	Learning Outcomes
PHP	Hypertext Preprocessor
PLOs	Programme Learning Outcomes
SME	Small and Medium-sized Enterprise
SQL	Structured Query Language
VET	Vocational Education and Training
VR/AR	Virtual reality/ Augmented reality
WEF	World Economic Forum
WP	Work Package

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History of versions

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1.3	15-06-2022	ICS, DIGITALEUROPE , Global Knowledge Netherlands	Final version approved by partners.

1. Executive Summary

1 Executive Summary

1.1 Introduction

The European Software Skills Alliance (ESSA) is a four-year transnational project funded under the EU's Erasmus+ programme. Its aim is to ensure the skills needs of the rapidly evolving software sector can be met.

This report "A Software Skills Strategy for Europe" is deliverable D.5,. It builds on the findings from the needs analysis (deliverable D.4.), in which the current and future needs for software skills in Europe were investigated, and also on several strategic meetings between work package leaders to define a feasible ESSA project strategy with the project life and beyond.

1.2 Objective

The developments in ICT have not only led to a shortage of software professionals to fulfil the increasing 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.

This Software Skills Strategy defines an approach with clear steps, mechanisms, and tools to overcome this skills gap in Europe.

The strategy provides solutions to guide actions and initiatives and may serve as inspiration in general to all those who are involved in the provision of software skills, as well as those who have a need for professionals with software skills.

1.3 Approach

The formulation of the strategy follows an iterative process of co-creation with the full ESSA partnership. This process spanned four months and was designed and planned with a set of predetermined deadlines, and clear interim deliverables. It was composed of multiple feedback rounds and discussion sessions. In this way, the strategy evolved in a step-wise manner, incorporating as much as possible all contributions from the partnership.

1.4 Results

The ESSA partnership formulated an integrated approach to overcome the skills gap, considering skills and roles needed now and in the future. The strategy links European policies to concrete actions and outputs.

The actions to overcome the skills gap are grouped into **10 clearly arranged steps**, that together will lead to a sustainable foundation with a coherent whole of actions, tools, mechanisms, and actors to address the software skills shortages and mismatches in a structured and comprehensive way.

The actions of the ESSA consortium are further guided by its **vision** on the development of software skills in Europe in the long run:

> *To foster strategic cooperation among stakeholders on skills development, ensuring a European long-term alliance of European key players in the software services sector.*

Aligned with this vision, ESSA's **mission** describes the way how ESSA will realise this vision and serve to define meaningful actions for the present and near future.

> *To provide current and future software professionals, learning providers, with the educational and training instruments they need to meet the demand for software skills in Europe.*

Following from the mission, a set of **strategic objectives** is derived that defines the concrete goals to be realized during and partly also after the project's duration. Finally, the strategic objectives are linked to **operational objectives** that describe concrete actions.

Strategic Objectives	Map, analyse and monitor skills needs	Identify market oriented software roles	Design and develop harmonised curricula	Validate learning processes	Boost awareness and stakeholder engagement	Foster cooperation and ensure sustainability
Operational objectives	Analyse current and future software skills needs Identify hard skills Identify profession-related skills Identify soft skills	Select software-related role profiles Adapt role profiles to market needs	Develop European educational profiles for software roles Design generic curricula Develop learning materials Localise and pilot the curricula	Design an accreditation system for the generic curricula Design a certification framework for individuals	Develop a communication strategy Drive stakeholders engagement Build a sustainable ESSA community	Develop European mobility programmes Create an ESSA network of associated partners Ensure sustainability of main project results

The Strategy is a **living document** that will be revised annually and adapted to current and future market trends in needs for software skills and roles.

1.5 Conclusions

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

Strategic objective 1. Map, analyse and monitor skills needs. The ESSA Alliance needs analysis focused on a first inventarisation and mapping of the skills needed for software professionals. The ESSA Alliance strategy review process continues this process and will provide an overview of the future and current demand for skills and role profiles for software professionals on a yearly basis. An important part in this process is the involvement of experts by means of expert groups, organised at national levels and European level. In this way, the expert groups function at the same time as a carriage to involve stakeholders and foster essential partnerships, embedding ESSA's activities in local contexts.

Strategic objective 2. Identify market-oriented software roles. The ESSA Alliance 5 selected professional role profiles for software professionals are evaluated given the current and projected market needs and adapted when relevant. Results from the needs analysis clearly indicated the importance of certain soft skills and profession-related skills in relation to all the selected software roles.

Strategic objective 3. Design and develop harmonised curricula. The ESSA Alliance harmonised curricula will be consistent and market-oriented. Therefore, a translation of market needs to educational concepts is necessary, which can be done by using educational profiles. There are several aspects that are important when looking at effectively and efficiently educating and training of software professionals like flexibility and modularity which directly link to individualised pathways and the recognition of earlier acquired skills. . Part of the development of these curricula are also the development of learning materials and the piloting of the curricula.

Strategic objective 4. Validate learning processes. The ESSA Alliance will focus on independent assessments of learning outcomes using professional assessment organisations. ESSA will develop an accreditation system for the learning programmes and a certification framework for skills for software professionals, based on the principles of micro credentialling and making use of digital badges.

Strategic objective 5. Boost awareness and stakeholder engagement. The ESSA Alliance designs, plans, and implements communication and dissemination activities oriented towards specific target groups involved in the ESSA activities and its ecosystem. The ultimate objective is the creation of a Software Skills Community enabling stakeholders to act as a network, share knowledge and insights, increase their visibility, identify trends, and advocate all together for software skills and professional quality.

Strategic objective 6. Foster cooperation and ensure sustainability. The ESSA Alliance fosters transnational cooperation and builds on stakeholder networks throughout the project lifecycle. The overall objective of this collaboration is to continuously research, identify and analyse the skills requirements of the European software sector, and then create and iteratively improve the Software Skills Strategy to develop innovative VET training programmes that will address the short, medium, and long-term needs of the sector, including emerging needs and new technologies and techniques that are currently being developed.

1.6 Use of this document

Because this document provides an integrated approach that addresses the multi-sectoral problem of the growing skills gap of software professionals, it is relevant to many different stakeholders in a variety of ways.

This strategy document informs policy makers and organisations such as social partners, chambers, and umbrella organisations about the concrete actions that will 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.

To the many organisations that have software development and operations needs and to education and training providers the document has an informative function but may also serve as inspiration in pointing out the concrete actions that ESSA will undertake.

In a more general sense, the document serves as a promotional tool, making explicit ESSA's mission and actions and hopefully motivates actors to follow or get in touch with ESSA to find out if and how their policies, strategies, initiatives, and actions can be aligned with ESSA's activities.

ESSA invites all its stakeholders to get in touch not only with the ESSA partnership, but more importantly, also with each other, and strengthen relationships in a sustainable manner in order to overcome the skills gap.

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2. State of play

2 State of play

The traditional role of a software professional is changing. New tools and technologies are emerging. The way software is developed is changing with organisations adopting agile methodologies in addition to a significant drive towards cloud-based application development and secure and sustainable development practices. All of these require the development of new ways of working, new skills, and competences. In addition, how and who developers work with is evolving, requiring more collaboration and teamwork as different roles and different professional fields within and outside the software life cycle work together to achieve the end result.

As the arena of software development is constantly changing, the market demand for software skills is also changing. Education and training to fulfil this changing market demand are essential.

2.1 Main trends and drivers

The WEF (2020)[1] Future of Jobs report states that technology adaption and automation will continue at a fast pace and are even expected to accelerate in the aftermath of COVID-19. Business leaders indicate that adaption of cloud computing, big data and e-commerce remain high priorities and that topics like encryption, non-humanoid and artificial intelligence are on the rise. They estimate that by 2025 as much as 85 million jobs worldwide will be displaced, while on the other hand even more new roles (estimated 97 million jobs) may emerge as a result of this digital transformation. The new skills needed by workers due to the digital transformation will result in that 50% of all employees need reskilling or upskilling before 2025. These are workers that will become redundant due to the digital transformation and also workers that will keep their role, but need to learn new skills to continue to be able to their job that is changed under the influence of new technology.

The other side of the coin is that new job opportunities will emerge, especially in the ICT sector. The WEF (2020) listed the top jobs that are increasing in demand and the top 10 completely exists of roles related to the ICT sector like data analysts, AI specialists, big data specialists, information security analysts and software and application developers.

2.2 EU initiatives and focal points

The European Commission (2021) declared this decade "**Europe's Digital Decade**"[2]. The foundation of this is the **Digital Strategy** the Commission announced in 2020[3]. To reach the goals of this Digital Strategy a **Digital Compass**[4] is developed to translate the ambitions in concrete terms. Part of the first of four cardinal points in this Digital Compass is about highly skilled digital professionals. The projected need for ICT specialists is 20 million by 2030 and given the current amount of specialists (7.8 million by 2019) and annual growth rate (4.2%) this demand cannot be met without actions and massive investment. An important

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[1] WEF (2020) - Future of Jobs report, available at: https://www.weforum.org/reports/the-future-of-jobs-report-2020/

[2] EC - Europe's Digital Decade, available at: https://digital-strategy.ec.europa.eu/en/policies/europes-digital-decade

[3] EC - Digital Strategy, available at: https://digital-strategy.ec.europa.eu/en

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

observation the Commission makes is that only one in six ICT specialists is a woman at the moment so women make up a large potential, and currently underused, source of skilled labour for the software profession.

To train Europeans to be ready for the digital world and to expand the talent pool, the EU is investing in programmes. These programmes include:

- **European Skills Agenda**[5]: a five-year overarching plan to help individuals and businesses develop more and better skills and to put them to use.
- **Pact for Skills**[6]: 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**[7]: 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**[8]: 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.

2.3 Standard related initiatives

The Erasmus+ requirements and the project plan specify that the ESSA project uses European standards in order to be recognisable and have a broad support across the wider European community.

The use of these European standards ensures a common language and point of reference when talking about specific software roles, competences, and skills. This optimises the process of the development of curricula through enabling communication with relevant stakeholders using a common reference point.

2.3.1 e-CF

Regarding ICT competences, specifically the **"EN 16234-1" e-Competence Framework (e-CF)** [9] - A common European Framework for ICT Professionals in all sectors - Part 1: Framework" is an important input for the ESSA Strategy. EN 16234-1 "e-CF" as a European norm, is a neutral standard, developed and maintained through an EU-wide balanced multi-stakeholder agreement process, under the umbrella of the European Committee for Standardization. The standard is also a key component of the European Digital Agenda for ICT Professionalism. The e-Competence Framework (e-CF) (EN 16234-1) identifies 41 competences related to the ICT professional field.

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[5] EC – European Skills Agenda, available at: https://ec.europa.eu/social/main.jsp?catId=1223&langId=en

[6] EC – Pact for Skills, available at: https://ec.europa.eu/social/main.jsp?catId=1517&langId=en

[7] EC - Digital Skills and Jobs Platform, available at: https://digital-skills-jobs.europa.eu/en

[8] EU - Digital Education Action Plan, available at: https://education.ec.europa.eu/focus-topics/digital-education/about/digital-education-action-plan

[9] 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

Being related very closely to the e-CF, the European standards **Foundational Body of Knowledge for the ICT profession**[10] (ICT BoK) and the **Guidelines for developing ICT Professional Curricula** [11] as scoped by EN16234-1 "e-CF" will also play a role in the development of this Strategy.

2.3.2 ICT professional role profiles

Besides the EN 16234-1 "e-CF", the "**CEN/CWA 16458-1 European ICT Professionals Role Profiles**[12] - Part 1: 30 ICT profiles" also forms a key input for the ESSA project.

The European ICT Professionals Role Profiles as described in CEN/CWA 16458-1 are based on and therefore closely related to EN 16234-1 "e-CF". They incorporate the competences of the e-CF as a main component within each profile. In total there are 30 ICT Professional Role Profiles distinguished that provide a generic set of typical roles performed by ICT Professionals in any organisation, covering the full ICT business process. The profiles are meant as "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".

2.3.3 ESCO

The **European Skills, Competences, Qualifications and Occupations (ESCO)**[13] is another important input. The ESCO classification identifies and categorises skills, competences, qualifications, and occupations relevant for the EU labour market and education & training. It also systematically shows the relationships between the different concepts. Unlike e-CF, ESCO makes no distinction between skills and competences.

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[10] 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=1037FF41 5D2B146EA5B76090895FB7FDD

[11] 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=169E994 0F2911D404FAE0D4872E5D2630

[12] 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/

[13] ESCO, available at: https://esco.ec.europa.eu/select-language?destination=/node/1

3. A step wise strategy

3   A step wise strategy

For an effective roll-out, implementation and sustainability of the ESSA Strategy, it is essential to apply a step-by-step methodology to approach the Sector Skills Strategy at the national or regional level. The ESSA strategy builds on 10 steps:

Steps	Definition	Timeline
Step 1. **Strategic view of the sector.**	Identification of the ESSA Skills Alliance main stakeholders, consultation and agreement of the mission and vision for the sector growth based on skills development.	2020 - 2021
Step 2. **Mapping the Software skills sector.**	Analysis of the current status of the sector: key players, mismatches, barriers and drivers.	2021
Step 3. **Defining strategic objectives.**	Definition of an overall draft strategy that will be updated on a yearly basis during the project life	2021
Step 4. **Analysing and assessing the skills mismatch in the sector.**	Elaboration of a needs analysis of the Software services skills sector.	2021
Step 5. **Monitoring the skills gaps.**	Monitoring the skills mismatch in the sector on a yearly basis, identifying gaps and shortages.	2022, 2023, and 2024
Step 6. **Identifying key activities.**	Identifying the key activities which support the Strategy, and planning its implementation during the project life.	2021 - 2024
Step 7. **Implementation of tools and community.**	National Implementation of the defined set of tools created to address the supply and demand mismatch and setting up a sustainable community.	2023 - 2024
Step 8. **Feedback loops and validation cycles.**	Yearly assessment and validation of key outputs (strategy, curricula, pilots, certification, mobility programmes, etc)	2021 and yearly updates
Step 9. **Recommendations for sustainability.**	Recommendations for sustainability and exploitation of the Strategy after the ESSA project funding period.	2024
Step 10. **Formal agreements within the ESSA Alliance.**	Formal agreements with the ESSA network of associated partners to ensure sustainable the development, exploitation, and localisation of the main ESSA outputs.	2024- after the ESSA project funding period

The following graphs introduces the main 10 steps that the ESSA strategy is considering as methodological approach for developing a strategic document.
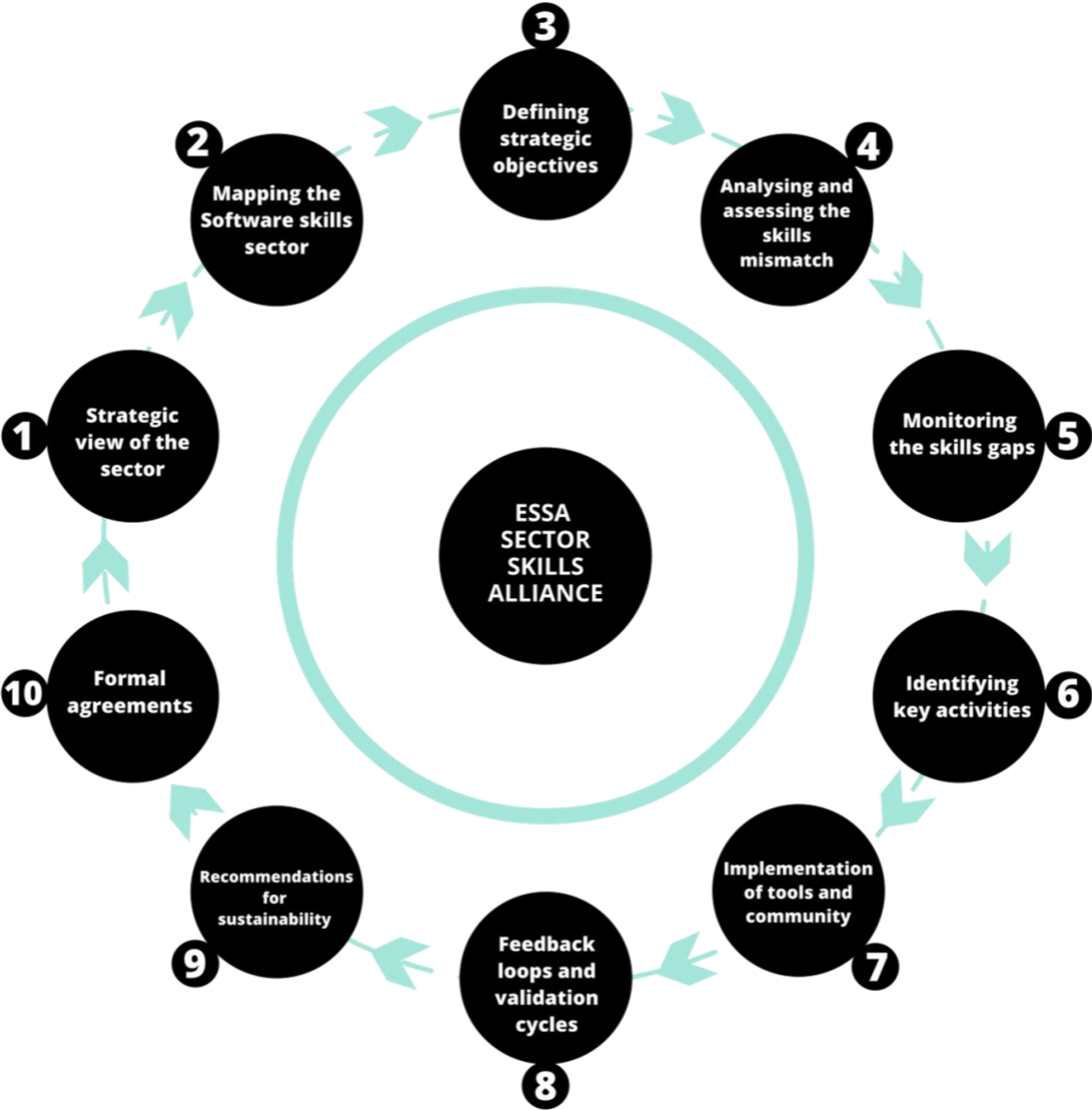

Figure 1: ESSA 10 strategy steps.

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4. Mission and vision

4 Vision and mission

The **European Software Skills Strategy** — a document that defines actions to bridge the software skills gap via Vocational Education and Training (VET) programmes has a clear vision, mission, and goal.

4.1 Vision

The **vision** of the ESSA Sector Skills Alliance is:

> *To foster strategic cooperation among stakeholders on skills development, ensuring a European long-term alliance of European key players in the software services sector.*

It recognises the responsibility of the software services community to plan for sector growth covering aspects of the industry challenges in relation to skills gaps.

4.2 Mission

The **overall mission** of the ESSA Alliance is:

> *To provide current and future software professionals and learning providers with the educational and training instruments they need to meet the demand for software skills in Europe.*

With a changing software arena and fluctuating skills, it is important to formulate a Software Skills Strategy that is resilient and also flexible enough to respond to future changes.

5. Scope of the strategy

The Software Skills Strategy has a clear demarcation on the subject area of software services, considering specific role profiles and competences, developing innovative VET programmes designed to match specific occupational profiles in software, and considering the heterogenous needs of a range of stakeholders.

5.1 Software services

The European Commission (2021) proposed a **Digital Compass**[14] to translate Europe's Digital Decade ambitions into concrete targets. Part of the first of four cardinal points is to have 20 million ICT specialists in the EU by 2030. These ICT specialists are referred to as highly skilled digital professionals.

A subgroup of these ICT or digital professionals are professionals working in software services. These professionals are working on the **development, implementation and operation of software.**

In this strategy, software skills refer to the 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. It is also not focused on other ICT professional sub-domains, like data analysis, IT security, and so on.

5.2 Role profiles and competences (skills, knowledge, attitude)

Role profiles (occupational profiles) and competences are an important aspect of the scope of this Strategy. Competences are a mixture or a combination of skills, knowledge, and attitudes that enable someone to successfully perform a task or an activity within a given context. They are also part of role profiles as required competences for a particular role. 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.

The CEN defined **European ICT Professional Role Profiles**[15] based on the competences of the **European e-Competence Framework**[16] ("e-CF") . ESSA adopts the European ICT Professional Role Profiles as a reference framework. These role profiles cover the whole ICT field and therefore a selection was made of the roles and competences that deal directly with the development and operation of software. The selected role profiles are the developer, the DevOps expert, the solution designer, the test specialist, and the technical (software) specialist. The findings from the Needs Analysis endorse this selection.

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[14] EC – Digital Compass, available at: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52021DC0118

[15] 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/

[16] 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=15E62ED24D608A5F10D6BEE8E6D50FA10Formal information, available at CEN & CENELEC: https://standards.cencenelec.eu/dyn/www/f?p=205:110:0::::FSP_PROJECT:67073&cs=15E62ED24D608A5F10D6BEE8E6D50FA10

Figure 2: *European ICT professional role profiles and ESSA scope.*

These role profiles are also at a fairly high level of abstraction so normally require organisations to add more detail to suit their particular needs. These selected role profiles are adjusted and expanded, based on the findings in the ESSA needs analysis.

These selected and adjusted role profiles will include the related competences from the European e-Competence Framework ("e-CF"), and underlying knowledge and skills.

As competences are typically composed of certain skills, knowledge and attitude, these are automatically included in the selection as well.

Figure 3: *Relation role profile, e-CF competences and skills*

5.3 Education and training

The approved and funded ESSA project description states that the main way for ESSA to reach its goals is by developing innovative **VET programmes** designed to match specific occupational profiles in software. This means that the VET programmes should educate 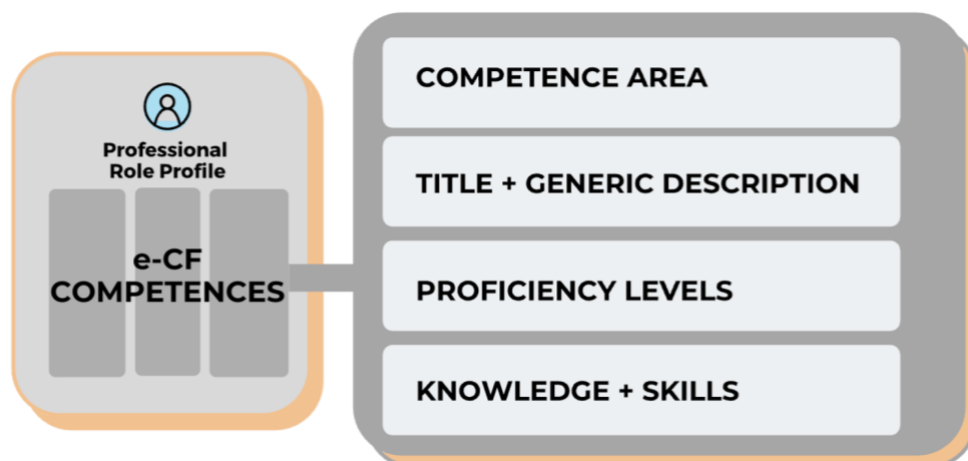for roles, competences, knowledge and skills that are indicated as central to this project. This implies that the European ICT Professional Role Profiles (CEN/CWA 16458-1) will be used, combined with relevant competences, skills, knowledge, and attitude from the European e-Competence Framework ("e-CF", EN 16234-1), as discussed in the former paragraph. Furthermore, the VET programmes should be on VET or higher VET level, incorporating upper secondary VET (EQF3/4), post-secondary/ tertiary VET (EQF 4/5), and higher VET (EQF 5/7).

The educational programme or training must be directly related to and prepare for the occupational field. Especially on the higher EQF levels extra attention has to be paid that the programme is *really* a VET programme or training and *not* a scientific or 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, ESSA is focused on formal learning, At the same time ESSA recognises the importance of non-formal and informal learning in skills development.

Besides VET programmes, **a certification framework** will be developed, that validates competences and skills, in a learning path independent manner. This implies that results from any form of learning, formal, non-formal, and informal learning can be officially recognised. In relation to software developers this is important, as they often use non-formal and informal ways of learning to upskill themselves.
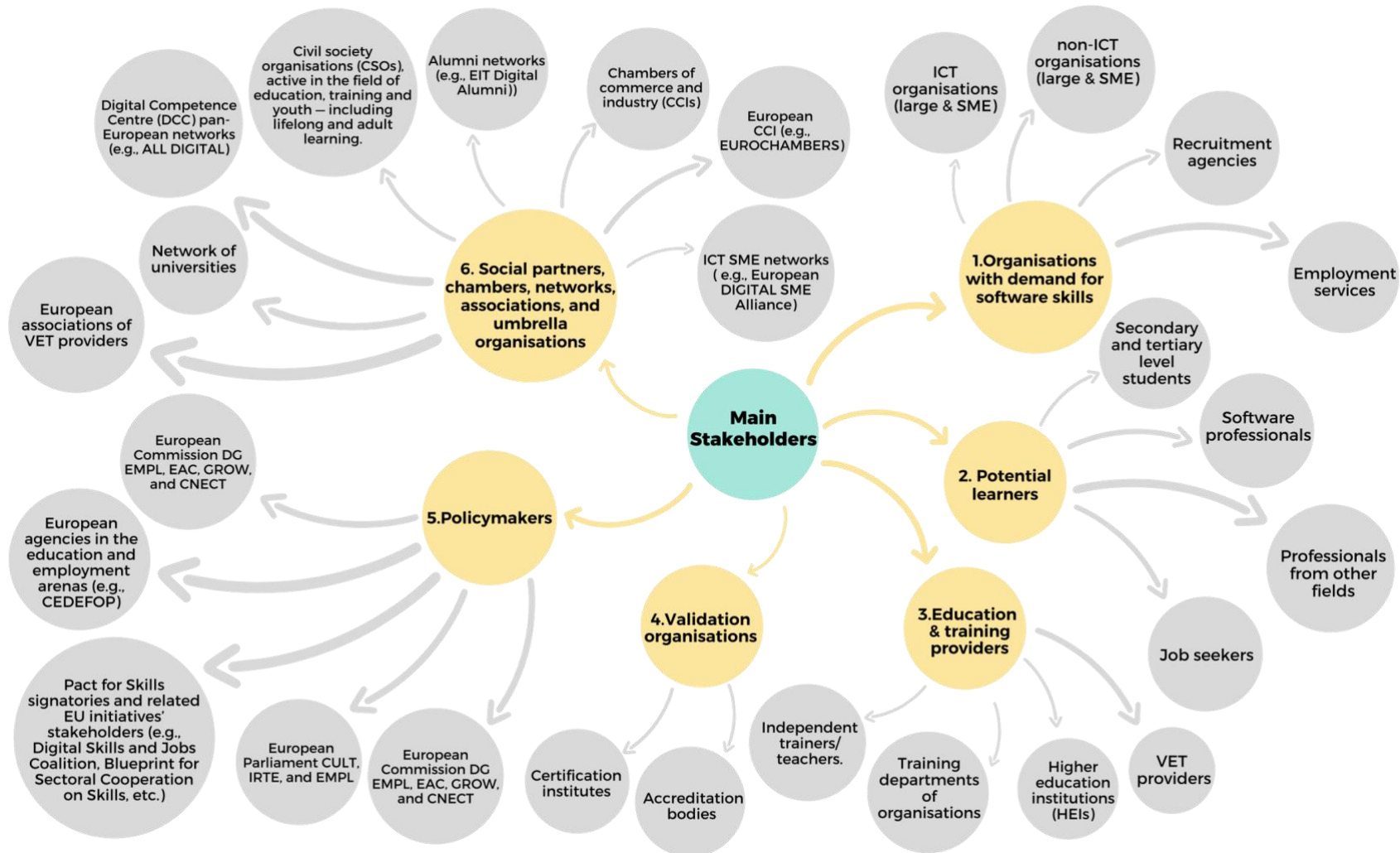
5.4 Main stakeholders

Figure 4: *Main ESSA stakeholders*

5.4.1 Organisations with demand for software skills

Important stakeholders are the organisations that will make use of the educated and trained software professionals. These **organisations with software development and operations needs** can be categorised into two main groups:

- IT organisations (large and SME) that develop & operate software
- Other organisations with their own software development & operation needs

Besides these two main groups also organisations that have the delegated task to find software personnel with the right skills belong to this category, such as recruitment agencies and employment services.

Organisations that use off-the-shelf software solutions are not targeted in this strategy since they do not employ software professionals.

5.4.2 Potential learners

The **software professionals** that have to fulfil the needs of organisations can be categorised in three groups:

- People following/ wanting to follow initial education in software roles (to **skill**), like secondary and tertiary level students.
- Professionals working in software roles (to **upskill**).
- 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. Given the fact that women make up only 22-35% of software developers in all EU countries, a key objective of the European Commission is to break down the barriers that prevent women entering software education and working in the profession, so this strategy will include ways to make software education and training more appealing and accessible for women.

5.4.3 Education and training providers

The group of formal learning providers consists of three subgroups that also have related partners in their eco-system that are important for the success of this strategy. These groups are:

- VET providers
- Higher VET providers including higher education institutes.
- Internal training departments of organisations.
- Independent trainers/ teachers.

5.4.4 Validation organisations

This group of stakeholders 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 provider complies to these criteria or standard. The group is composed of:

- Accreditation bodies
- Certification institutes

5.4.5 Policy makers

Policymakers at national and European level are also an important group of stakeholders. Some examples of policy makers directly connected with the ESSA strategy are as follows:

- European Commission (DG EMPL, EAC, GROW, and CNECT)
- European Parliament (CULT, IRTE, and EMPL)
- Pact for Skills signatories and related EU initiatives' stakeholders (e.g., Digital Skills and Jobs Coalition, Blueprint for Sectoral Cooperation on Skills, etc.)
- European agencies in the education and employment arenas (e.g., CEDEFOP, ESCO)
- National policymakers that determine VET curricula, accreditation and certification.

5.4.6 Social partners, chambers, networks, associations, and umbrella organisations

This is a broad and diverse group of different types of stakeholders that can have a direct or more indirect interest in ESSA and this strategy, depending on their members and the group(s) they represent. These are:

- European associations of VET providers
- Network of universities
- Digital Competence Centre (DCC) pan-European networks (e.g., ALL DIGITAL)
- Civil society organisations (CSOs), active in the field of education, training and youth — including lifelong and adult learning.Alumni networks (e.g., EIT Digital Alumni)
- Chambers of commerce and industry (CCIs)
- European CCI (e.g., EUROCHAMBERS)
- ICT SME networks (e.g., European DIGITAL SME Alliance)

6. Strategic objectives

6 Strategic objectives

The ESSA strategy has set up six main strategic objectives that are realised within the framework of the ESSA project (December 2021-November 2024). Each strategic objective has operational objectives and a set of activities involving ESSA partners and other stakeholders.

Strategic Objectives	Map, analyse and monitor skills needs	Identify market-oriented software roles	Design and develop harmonised curricula	Validate learning processes	Boost awareness and stakeholder engagement	Foster cooperation and ensure sustainability
Operational objectives	Analyse current and future software skills needs Identify hard skills Identify profession-related skills Identify soft skills	Select software-related role profiles Adapt role profiles to market needs	Develop European educational profiles for software roles Design generic curricula Develop learning materials Localise and pilot the curricula	Design an accreditation system for the generic curricula Design a certification framework for individuals	Develop a communication strategy Drive key stakeholders' engagement Build a sustainable ESSA Community	Develop European mobility programmes Create an ESSA network of associated partners Ensure sustainability of main project results

Figure 5: Strategic and operational objectives.

6.1 Strategic objective 1. Map, analyse and monitor skills needs

Skills refer to a person's abilities to do something; they are essential in a professional context and are key elements of professional roles. They 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. Therefore, it is necessary to determine the skills needed at a certain point in time and monitor and predict their changes over time.

The initial ESSA needs analysis indicated the most important skills for software professionals. These are hard skills, profession-related skills, and soft skills which are becoming increasingly important.

Main target groups involved:

ICT organisations, large organisations, SMEs, recruitment agencies, education and training providers, policy makers.

Key topics covered:

Needs analysis, monitoring skills needs, hard skills, profession-related skills, interpersonal and personal soft skills.

Roadmap:

Map, analyse, and monitor skills needs.	ESSA PERIOD				POST ESSA		
	2021	2022	2023	2024	2025	2026	2030
Analyse current and future software skills needs.	Initial needs analysis	Yearly update	Yearly update	Yearly update	Yearly update	Yearly update	Yearly update
Identify hard skills.	■	■	■	■	■	■	■
Identify profession related skills.	■	■	■	■	■	■	■
Identify soft skills.	■	■	■	■	■	■	■

6.1.1 Analyse current and future software skills needs

The report "Europe's Most Needed Software Roles and Skills", in short "needs analysis" that was conducted within the first part of the ESSA project is an important foundation to build the Strategy upon. In this needs analysis, the current and the future needs for software skills in Europe and the nature of the skills gap that needs to be filled were investigated by the ESSA partnership. The research led to a set of concrete conclusions to build this Software Skills Strategy upon.

6.1.1.1 Mapped and analysed skills needs

The needs analysis showed that several skills are important to perform well in a software role. These are certain hard software skills, but also other profession-related skills and more generic soft skills. Training in these skills is therefore essential to obtain properly skilled software professionals. These skills should also be the central part of skilling and reskilling programmes.
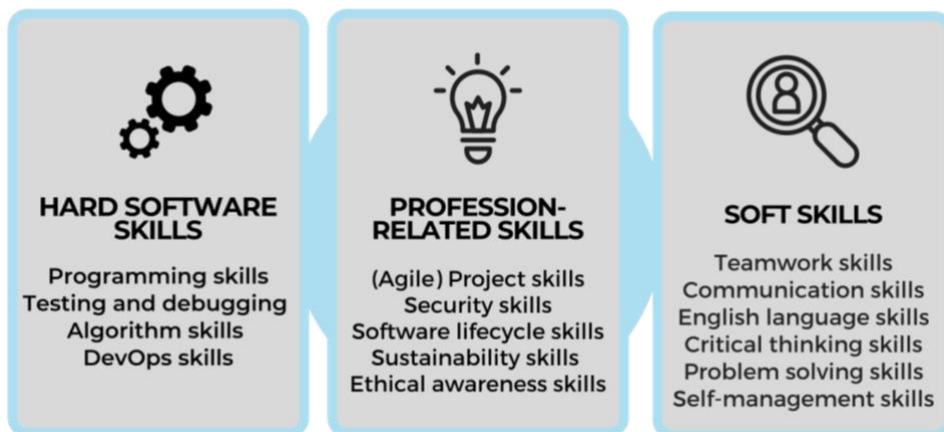
Figure 6: Overview of essential skills for software professionals.

6.1.1.2 Monitor skills needs

An annual strategy review process is designed where structured feedback is collected from training providers and key labour market stakeholders and combined with the latest market needs forecasts to inform improvements of this strategy. The strategy review process consists of different steps, that will provide an overview of the future and current demand for skills and role profiles for software professionals. An important part in this process is the involvement of experts by means of expert groups, organised at national levels and European level. In this way the expert groups function at the same time as a carriage to involve stakeholders and foster essential partnerships, embedding ESSA's activities in local contexts.

6.1.2 Identify hard software skills

Hard software related skills are primarily focused around programming skills, 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.

6.1.2.1 Programming skills

The needs analysis revealed that 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 use 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**.

6.1.2.2 Other hard skills

Besides programming skills, other important hard skills related to software production and maintenance are:
- Testing and debugging
- Algorithm skills
- DevOps skills

The findings in the needs analysis show that the ability to work with algorithms is also very important, besides programming skills. 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. DevOps skills somewhat more than testing skills.

6.1.3 Identify 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. So, these skills are related to the field of the software professional, but also to the ICT professional in general. They may be considered essential for functioning in this kind of role. The needs analysis revealed that the most relevant skills are (agile) project skills, security skills, software lifecycle skills, sustainability skills and ethical awareness skills.

6.1.3.1 (Agile) project skills

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. Specific agile project skills are therefore also required.

6.1.3.2 Security skills

Security is an issue that is already important and is gaining more relevance. Security is now an integral part of the whole cycle of designing, developing, deployment and maintenance.

6.1.3.3 Software lifecycle skills

Having a deep understanding of the whole development lifecycle is considered important for all software professionals. It is also useful to have an awareness and understanding of the broader context of one's activities and tasks as a software professional is necessary.

The ability to actively apply and integrate different methods and techniques within the whole of the software lifecycle is especially important when it comes to continuous integration and continuous deployment.

6.1.3.4 Sustainability skills

Sustainable development in a general sense is a core principle of the Treaty on European Union (operative from 1993) and a priority objective for the Union's internal and external

policies. The **United Nations 2030 Agenda**[17] includes 17 Sustainable Development Goals (SDGs) intended to apply universally to all countries. One of those SDG's relates to Technology and states that:

> *"...the research, development, deployment, and widespread diffusion of environmentally sound technologies in the context of a Green Economy is also closely linked to other core elements and means of implementation, including innovation, business opportunities and development, ..."*

In relation to these ambitions of the EU and growing importance of the topic, it is expected that in the future sustainability management and sustainable software development will become important. This is also strongly supported by the European expert group that was held in the context of ESSA's needs analysis.

6.1.3.5 Ethical awareness skills

There is evidence from the research literature and the general media of an increasing disquiet from the public and some governments over the potential of software to cause harm, either through malicious misuse or the inadvertent negative effects of lack of due care. This is most notable in terms of newer 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. For current and future software professionals it is likely to become 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. 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. Professional ethics is also a building block of the European Commission ICT professionalism programme.

6.1.4 Identify soft skills

The skills needed in software roles are certainly not restricted to hard software skills and other profession-related skills. There is the growing importance of soft skills that are needed to be successful as a software professional. These skills already are called "essential" and they are becoming increasingly more important skills for a software professional to be able to perform tasks well. The skills themselves are transferable and are also useful and necessary in other professional fields.

6.1.4.1 Interpersonal 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.

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[17] UN Sustainable Development Agenda, available at:
https://www.un.org/sustainabledevelopment/development-agenda/

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.

6.1.4.2 Personal soft skills

Personal soft skills are becoming increasingly important for people in software roles. The most important are **critical thinking & analysis**, **problem solving** and **self-management**. This is confirmed not only by the findings in the ESSA needs analysis, but also in many other (EU) reports and studies. The skill self-management has become even more important during the COVID-19 pandemic, because a lot of professionals had to work (even) more autonomous than before the pandemic.

Personal soft skills, especially the three mentioned, are important for people in any working environment and certainly for software professionals.

6.2 Strategic objective 2. Identify market-oriented software roles.

The ICT professional role profiles relevant for software are adjusted to fit the current and future market needs. There is a need for a lot of extra software professionals in the coming decade and beyond.   The challenge is to educate software professionals relevant skills to meet market demand.

The European ICT Professional Role Profiles (CEN/CWA 16458-1) incorporate the competences of the European e-Competence Framework ("e-CF", EN 16234-1) and are used as a foundation and starting point. These role profiles are adjusted to reflect better the growing importance of soft skills and other general profession related skills.

Main target groups involved:

ICT organisations, large organisations, SMEs, recruitment agencies, education and training providers, policy makers.

Key topics covered:

Importance of software roles, adjusted profiles for software roles, shaped professionals (T-, π-, M, comb- and E-shaped).

Roadmap:

Identify market oriented software roles	2021	2022	2023	2024	2025	2026	2030
	ESSA PERIOD				POST ESSA		
Select software related role profiles	■						
Adapt role profiles to market needs	■	Focus on T- & π-shaped professionals			Focus on broader shaped professionals		

6.2.1 Select software-related role profiles

From the 30 CEN ICT Professional Role Profiles, ESSA selected software-related profiles and analysed them. This resulted in a list of roles that require software skills as an essential part

of their profile, as well as, some relevant aspects related to the contents of those selected role profiles. The Needs analysis showed five CEN ICT Professional Role Profiles that have software development and operation as an essential element of their role. The relative importance of these roles is also analysed which resulted in a priority list that guides the focus of the ESSA skill, upskill and reskill activities.

Table. Relative importance of software roles

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

Although in other roles software-related aspects may play a role to a certain extent, these roles are out of the scope of the ESSA 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.

The 5 abovementioned occupational profiles were analysed in ESSA's needs analysis report and are used to adjust the software-relevant profiles. One of the main conclusions is the overall importance of soft skills and their relevance to all selected role profiles. Another important development that is to be noted is the rise of T-shaped and π-shaped professionals.

6.2.1.1 Different shaped professionals

Many software professionals still are I-shaped professionals. These professionals 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 hard to work with them 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 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 professional. Other variations of combinations of skill sets are E- and X-shaped professionals. 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. Professionals will need to re- and upskill themselves continuously, developing more complex skillsets. The first step however, is to make sure that we no longer have I-shaped software professionals, but that they are all at least T-shaped. The focus is on creating π-shaped professionals by reskilling professionals from other fields.

6.2.1.2 Specialisation(s) to stand on

Within the concept of the shaped professional, the vertical specialisation part is equally important as the horizontal broad part. The broad part refers to a skill set and attitude that form a base for potential cooperation with other kinds of specialists from other fields. This means that professionals should have deep knowledge of one subject, but also need to have skills to work with others from other fields.

Professionals with two specialisations that can be combined will be needed. 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. A good example is the combination of marketing and ICT. Reskilling people from other fields will create these professionals.

6.2.1.3 Broad reach through (profession-related and soft) skills

With ESSA's needs analysis report, it became clear that certain skills are relevant to all of the 5 selected software roles. These are two types of skills: one type of skills is profession-related, and the other are soft skills, at a personal and interpersonal level.

Profession-related skills are relevant to the broader ICT sector, such as skills in the areas of security and project management. The soft skills have an even broader range and are not only relevant in the software profession but are also relevant in other professional fields and domains.

Both types of 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.

6.2.2 Adapt role profiles to market needs

The 5 selected professional role profiles are evaluated given the current and projected market needs and adapted when relevant. Results from the needs analysis clearly indicated the importance of certain soft skills and profession-related skills in relation to all the selected software roles. Thus, a transferable skill set of soft skills and a software profession-related skill set to all the selected software role profiles was added. Minor changes, in the form of adding some competences to certain role profiles were also done.

An important finding is that new role names like AI Developer, VR/AR designer, full stack developer and blockchain developer are all variations of the more general five role profiles, so are already covered by these profiles,

Detailed information on the adapted role profiles can be found in the document "ESSA Software professional role profiles".

6.3 Strategic objective 3: Design & develop harmonised curricula

The design and development of harmonised curricula that reflect these roles in a consistent and market-oriented way is crucial. To design and develop this kind of curricula, a translation of market needs to educational concepts, which can be done by using educational profiles.

There are several aspects that are important when looking at effectively and efficiently educating and training of software professionals like flexibility and modularity which directly link to individualised pathways and the recognition of earlier acquired skills.

Curricula are designed and developed based on educational profiles and these aspects. The curricula are piloted to test their effectiveness.

Main target groups involved:

Education and training providers, initial students, reskillers, upskillers,

Key topics covered:

Educational profiles for software roles, up- & reskilling programmes, localisation of curricula, modularity of curricula, individualised learning pathways, developing learning materials, piloting programmes.

Roadmap:

Design and develop harmonised curricula	ESSA PERIOD				POST ESSA		
	2021	2022	2023	2024	2025	2026	2030
Develop European educational profiles for software roles		■		Update			
Design generic curricula		■		Update			
Develop training materials			■	Update			
Localise and pilot the curricula			■		Rollout of harmonised curricula		

6.3.1 Develop European educational profiles for software roles

6.3.1.1 The educational profile

CEN has described a method to translate relevant market demands into structured learning programmes. This method is described in the report Guidelines for developing ICT Professional Curricula as scoped by EN16234-1 "e-CF"[18] .

The method is the educational profile, a structure that enables a competence-oriented curriculum design as it translates occupational profiles and competences into learning programmes by formulating a set of programme learning outcomes, learning outcomes and assessments. Besides this, also a description is added with characteristics of the profile, independent of detailed design aspects of a concrete learning programme.

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[18] 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:723 63,1218399&cs=169E9940F2911D404FAE0D4872E5D2630

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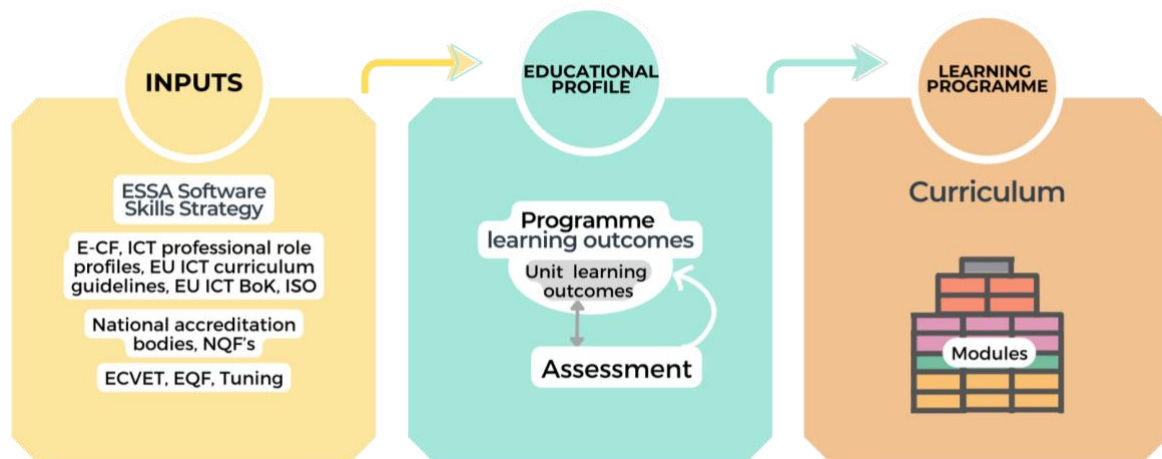

Figure 7: *the position of the educational profile.*

6.3.1.2 Starting points for educational profiles for software roles

ESSA will develop educational profiles that will be the basis of development of the VET curricula and programmes for software skills.

Market needs are reflected in the ESSA needs analysis and in this strategy, but also in the adapted software professional role profiles, e-CF, and related reports.
Recently, the ICT Foundational Body of Knowledge (ICT BoK) was developed, aligned with the e-CF. In this ICT BoK a set of knowledge units is distinguished that is relevant to all professionals working in ICT, regardless of job function.
Related to the level of complexity and autonomy, qualification frameworks like the EQF, ECVET and national qualification frameworks will be used to determine the right level for positioning the PLOs and LOs.

All these elements are used as input in developing educational profiles and to determine the contents of the programme learning outcomes (PLOs) and learning outcomes (LOs), keeping the following in mind:

- Different educational profiles will be developed for the different software professional roles with different levels of complexity
- The set of educational profiles together will offer a complete scheme. They will be offered in a structured way and possible learning paths relating to skilling, reskilling and upskilling will be indicated
- ESSA Educational profiles will be developed for the whole of the EU, however there will be room for contextualising the profile to local conditions. It will be explained how this can be done
- There will be one generic set of PLOs and LOs related to the transferable soft skill set and profession-related skill set as described above. These generic sets will be part of every educational profile that is focused on a full professional role
- The common ICT knowledge as described in the European Foundational Body of Knowledge for the ICT profession, that is applicable to all ICT professionals and will be

part of every educational profile that is focused on a full professional role. More advanced knowledge that is part of this ICT BoK and relates to the ESSA software roles will be considered when developing learning outcomes for a specific role

- Learning outcomes will be described in a standardised way, according to defined principles
- The educational profiles will be formulated in a vendor-neutral way. Depending on the specific market demand in a specific local context, the learning provider can select certain vendors and specific certificates

The educational profiles will provide enough information and detail to develop learning programmes upon, and at the same time will be generic enough, so that flexible interpretations at local levels are possible

6.3.2 Design generic curricula

Central to creating more software professionals is the skilling and reskilling of people. This consists of initial educational programmes that skill new, young professionals and of reskilling programmes to reskill professionals to software professionals.

6.3.2.1 Initial educational programmes

Software professionals are skilled in formal, initial education at VET level, but mostly on higher VET level given the increased complexity of the profession.

Research and the needs analysis reveal that 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, both on VET and on higher VET level.

As the selected and adjusted ESSA software role profiles take into account these important skills, they also will be part of the educational profiles, that are the blueprints for the educational programmes. In this way it is ensured that essential elements such as working in a business environment and soft skills are an integral part of these educational profiles and will become part of the educational programmes as well.

6.3.2.2 Reskilling programmes

Reskilling professionals from other fields to become software professionals will create professionals with expertise in multiple professional fields, like π-shaped or comb-shaped professionals, that can bridge two fields or more which can be of much added value in a business environment. ESSA will facilitate the training of these multi-shaped professionals who will be professionals in their original field(s) and software professionals.

Working with educational profiles makes clear what learning outcomes somebody must demonstrate to be a software professional. It does not matter whether somebody obtains these learning outcomes by training or by previously acquired competences. Modular programmes in which a module is targeting only one or a few unit learning outcome(s) will make it possible to develop tailormade learning paths for professionals that want to reskill.

The professional can either start as an I-shaped or a T-shaped professional, but both will be trained as a π-shaped professional. The learning path will depend on their background and already acquired skills.

The advantage of reskilled π-shaped professionals is of course that they already know the business domain. It is also a logical choice for organisations in times of digital transformation. The expectation is, for example, that a lot of the work of accountants will be automated.

On the other hand, these organisations will need software professionals to program and maintain the software that will take over the work. Reskilling accountants instead of making them redundant, would then be a good solution, because they will have π-shaped professionals with skills related to their field and software.

6.3.2.3 Exemptions for previous learning

ESSA will support efficiency in reskilling programmes by enabling exemptions based on already acquired skills for learning units in these programmes. Programmes that are designed in a modular way, are composed of small discrete modules or learning units that are virtually self-contained, independent, nonsequential, and typically short in duration. One of the advantages of modular programmes is that people that already possess relevant competences, skills or knowledge, can have exemptions from certain parts of the programme. This facilitates efficient reskilling because the use of well-designed exemptions reduces needless and tedious repetition. This speeds up the completion of the programme and makes it more attractive for students and employers. Modularity makes it easier to have an optimised process for exemptions.

6.3.2.4 Individualised pathways

ESSA will promote the use of individualised learning pathways. People do not only learn in formal learning situations and there is no one learning method that suits everyone. Learners will therefore benefit from individualised learning pathways although they still need to achieve the same learning outcomes.

Exemptions are a tool to create individualised pathways. Prerequisite for that is assessing whether somebody already obtained a certain learning outcome. ESSA will develop assessment criteria to facilitate individualised pathways.

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. ESSA will provide examples in the programmes on how to achieve the same learning outcome using different learning methods.

6.3.3 Develop learning materials

6.3.3.1 Up to date training

ESSA will provide up-to-date training materials and mechanisms to facilitate continuous and easy updating after the project's end. In a field like software development and operation, it is inevitable that training (materials and methods) will need to be updated on a regular basis. The collaboration between organisations and learning providers will also provide insights on the extent to which the provided training materials are up to date. Here are three important points of attention:

1. **Methods and materials must be up to date to start with:** Given the actual software skills gap, we can assume that a large part of the methods and materials currently used are outdated. New methods and materials should be reviewed by organisations to confirm whether they will educate and train the desired skills.
2. **Training of soft skills:** It is tempting to train transferable skills in a generic way — for all kinds of (future) professionals, i.e., a "one-fits-all" approach. Software professionals though encounter specific challenges in soft skills. For example, they need to learn to explain complex, technical innovations to the rest of the organisation. Thus, the development of soft skills should be tailored to their specific needs.
3. **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.

6.3.3.2 Flexible training

An important finding of ESSA's Needs Analysis Report is that people in organisations have little time to up- or reskill. To deal with this issue, solutions like short, flexible training and alternative ways of delivering training must be considered.

6.3.3.3 Self-paced

ESSA will promote the idea of self-paced training when possible and instructor-paced learning when needed. Training that can be followed at a suitable time and at a pace that is manageable for the learner will drastically increase the opportunities to undertake training. 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.

It must also be recognised that teachers and instructors have added value in the learning process. A lot of delivery methods in education depend on the teachers and their expertise. Expertise, in our case, consists of software 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.

6.3.3.4 Modular training

Dividing training into small modules makes it more flexible. It is for most people easier to free up short moments to study than, for example, complete days. The concept of microlearning is based on this principle. Microlearning is learning in small units which takes a learner about ten minutes to complete. The advantage of this concept is of course its flexibility, but the disadvantage is that it is not applicable to everything. Some things cannot be broken up in units this small simply because they are, for example, too complex or just take more time. Microlearning can help to make learning more flexible and therefore more accessible, but only in situations in which this does not impede or damage the learning

process. ESSA will promote the concept of microlearning in situations where this learning approach is possible.

6.3.3.5 Innovative methods of delivery

ESSA will encourage the use of innovative and engaging ways of delivering training. New methods of delivering training can help to improve the quality of learning. All of them shift the centrality from the teacher to the student, from the transmissive lesson to activities through which the learners construct their own knowledge and develop skills and competences. All these methods are based on the theory of "pedagogical activism":

- **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.
- **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.
- **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.
- **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.

These are some examples of popular innovative ways of delivering training, but other methods are also possible. The use of these methods depends on the situation.

6.3.4 Localise and pilot the curricula

6.3.4.1 Localisation of curricula

ESSA will develop educational profiles and corresponding curricula in such a way that local needs can be fulfilled, while ensuring they are generic enough for European wide recognition. The learning outcomes defined in the educational profiles will be formulated in such a way that it is possible to meet specific local demands and still be in line with the profile. It also means that learning outcomes will be defined with existing national curricula in mind. By formulating learning outcomes in such a way that they encompass national defined learning outcomes (or learning goals/ objectives if they work with those) the European recognition will rise.

Examples of local needs can be a specific programming language that is often used in a certain region or in a certain important industry. It can also be that a specific profession-related skill or soft skill is extra important given the national or regional situation.

6.3.4.2 Piloting of curricula

The curricula will be piloted by means of several VET training programmes across different target groups in different countries. Work-based learning components including practical "real life" training scenarios related to each role will be used to incorporate professional practice in the training programmes. Local employers will be engaged to offer internships, apprenticeships, and job placement for the graduates. Based on feedback from the pilot testing the curriculum and training programmes will be updated.

6.4 Strategic objective 4: Validate learning processes

It is important that learning is validated with certification to establish whether somebody is an up-to-date software professional. This stimulates mobility of software professionals, increases the professionalism of the software field, and supports lifelong learning. It is also important that learning providers deliver accredited programmes so learners can trust that a programme leads to the relevant learning outcomes.

Learning is not only about formal learning and official qualifications. People learn all the time through non-formal and informal learning. The issue is that it is hard to verify whether somebody possesses a certain skill if there is no formal recognition of it. People can state it in their resume or during a job interview, but that is no objective assessment and, most of the times, it is hard to verify. Objective validation is therefore important for the recognition and mobility of software professionals. Assessments are a way to validate whether somebody achieved a learning outcome. ESSA will focus on independent assessments of learning outcomes using professional assessment organisations. The fact that the achievement of learning outcomes will be assessed, means that when the learning outcomes are internationally recognised also the assessments will be internationally recognised. This will promote cross border mobility.

Main target groups involved:

Education and training providers, certification institutes, accreditation bodies, initial students, reskillers, upskillers, policy makers

Key topics covered: assessment, certification of individuals, accreditation of programmes, recognition of learning outcomes, micro credentialling, digital badges.

Roadmap:

6.4.1 Design an accreditation system

It may be tempting for learning providers and employers just to look at the desired hard skill at that moment and forget about other important skills like soft skills or broader profession-related skills needed to stay relevant as a software professional. A software professional is not somebody though that only can programme in one or two languages, but it is a professional with certain competences that include a specific skill set and knowledge. To be sure that somebody is a software professional that meets an ICT professional role profile, a professional should possess a degree obtained from an accredited programme. It is established that such a programme leads to obtaining the learning outcomes defined in the educational profile and therefore educates a software professional.

This holds of course for complete skilling programmes, but also for reskilling programmes. Also upskilling training can be accredited when it is proven that the training leads to a learning outcome that is part of the educational profile.

In all cases there must be an assessment whether the learning outcome is indeed achieved. Preferably by independent organisations or at least through learning path independent testing. ESSA will develop an accreditation system for programmes that are meeting the criteria ESSA will formulate.

6.4.2 Design a certification framework

People who successfully complete a training or course can be certified for this. This does not include certificates of participation, because, in that case, there is no proof that the learning outcomes are achieved. There must be an assessment that proves whether the intended learning outcome is achieved.

Traditionally, certificates covered a lot of knowledge and skills that was assessed at once. This was cost-effective and people needed only one paper certificate to prove knowledge or a skill. This has changed in the digital age. It is now possible, using micro credentialling and digital badges, to recognise relatively small (parts of) skills and knowledge. These can be linked to only ten minutes of learning material (microlearning) but they are typically covering a bigger unit (like e.g., 1 ECTS/ 28 hours of learning).

ESSA will create certifications for software skills based on the principles of micro credentialling making use of digital badges. The ESSA certification framework will entail 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. The final level is a badge indicating that somebody has acquired the competences related to a complete role profile.

The system of digital badges also prevents problems like the authentication of paper certificates. This is especially valuable for upskilling. Professionals can learn a new skill in the field and add it to their digital resume. They can do that at their own pace, for example: one small badge every month, a few at once, or a whole group of badges at once. The framework will also connect to the **European Digital Credentials for Learning** tool of **Europass**[19] and consider already existing vendor certifications for the selected role profiles.

Certification is also a useful tool in complete skilling or reskilling programmes. A number of learning outcomes can be assessed, and certificates awarded. The most common example is a module or course in a programme that is completed by an exam of an independent institute. First of all, certification by independent institutes increases in most cases the value

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[19] Europass, available at: https://europa.eu/europass/en/european-digital-credentials-learning

of the programme. It is learning path independent testing which means that the result does not (partly) depend on course dependent activities like attendance or in-class group work. Learning path independent testing also provides the opportunity for people to have individualised learning pathways, but still achieve the same learning outcome validated by the same certificate.

6.5 Strategic objective 5: Boost awareness and stakeholder engagement.

It is of critical importance to boost awareness and stakeholder engagement in ESSA to tackle the software skills gaps that have been identified and will be periodically updated. Only if people are aware of the software professional requirements, the labour market needs, and available education and training pathways can we answer the lack of software professionals in the EU.

To boost awareness and stakeholder engagement, ESSA designs, plans, and implements communication and dissemination activities oriented towards specific target groups involved in the ESSA activities, its ecosystem, and beyond. The main related objectives are:

- Deliver a consistent message about the software skills needs and in-demand software role profiles.
- Spread the word about ESSA's potential and capability to tackle the need for skilling, reskilling, and upskilling the EU's workforce in the software sector in line with latest market requirements.
- Promote the Software Skills Strategy to the EU and local policymakers as a solution to reach Europe's KPIs – today and tomorrow. Ensure the uptake of the European Software Skills Strategy by the software industry and organisations with demand in software skills at the local and European levels.
- Identify VET providers, support and encourage them to use the ESSA developed European VET programmes, ready-to-use materials (i.e., VET support tool), and recognise new qualifications.
- Ensure the use of the VET curriculum search tool by end-users (students, employees, lifelong learners) and successfully connect the demand to the offer (education and training providers).
- Prompt stakeholders to join, collaborate, and be active members of the Software Skills Community.
- Promote Software as a career choice to young people and adults of all ages across Europe.

Main target groups involved: Education, training, accreditation and certification providers, Organisations with demand in software skills, Potential learners and young people, EU and national policymakers, and Social partners, chambers, networks, associations, and umbrella organisations.

Key topics covered: communication, dissemination, website, social networks, stakeholders, community, events.

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Roadmap:

Boost awareness and stakeholder engagement	ESSA PERIOD				POST ESSA		
	2021	2022	2023	2024	2025	2026	2030
Develop a communication strategy	████						
Drive stakeholders engagement		Stakeholders engagement in ESSA activities			Stakeholders engagement in ESSA sustainability		
Build a sustainable ESSA community		Community launch	ESSA community roll -out		Sustainable ESSA community		

6.5.1 Develop a communication strategy

ESSA sets a clear framework by establishing a common communication strategy to ensure consistent and coherent communication and dissemination activities throughout the project's lifetime (2021-2024).

The ESSA communication strategy supports the following key points:

- Raising awareness about ESSA's value propositions towards key stakeholder groups,
- Ensuring the dissemination and adoption of the project outputs – notably, the European Software Skills Strategy, Vocational curricula, education and training programmes and certification framework, and Software Skills Community – by the respective end-users and beyond,
- Supporting ESSA's partners and its ecosystem in the awareness raising and stakeholder engagement efforts within their local environments to ensure EU-wide adoption of the results during and after the project duration, and, in turn, bring forward socio-economic benefits for the entire EU software sector.

The ESSA communication strategy outlines ESSA's value propositions, key stakeholders and messages, and key performance indicators (KPIs). It also outlines the promotional activities and campaigns planned at the different stages of the project. The Communication Strategy is a living document that will be revised periodically and adapted to the needs of the Alliance.

6.5.1.1 ESSA promotional strategy

The promotional strategy presents the tactics that will be deployed over the lifetime of the project to reach, act towards, convert, and engage (RACE) each of the target groups; thus, creating widespread awareness and interest in the project. The promotional strategy is oriented to raise stakeholder engagement following a 4 stepwise approach:

- **Reach:** Build brand awareness, increase online visibility, grow the audience on multiple channels.
- **Act**: Prompt interactions, subscribers and leads, increase the positive sentiment vis-à-vis the project and outputs.
- **Convert:** Persuade key stakeholders to use the project results, increase brand trust.
- **Engage:** Encourage the multiplying effect, reward users, activate the community.

6.5.1.2 ESSA communication tools

The main communication tools that will be used for the dissemination and outreach activities of the European Software Skills Alliance project are: the ESSA website, social media accounts (Twitter and LinkedIn), mailing and newsletters, press releases, online and on-site events and visual assets with information about ESSA.

6.5.2 Drive key stakeholders' engagement

Key stakeholders of ESSA will be engaged throughout and after the project ends, using various contents, content types, and strategies.

6.5.2.1 Addressing organisations with demand in software skills and roles

In ESSA we engage with organisations through various channels and means, mainly LinkedIn, the ESSA partner network, website, webinars, and business associations.

EU-wide campaigns will be deployed in 2023 and 2024 to reach this target groups with the aim to:

- Encourage the adoption the ESSA outputs
- Ensure software roles are filled
- Promote the adoption of the ESSA educational profiles and certification framework

6.5.2.2 Addressing education and training providers

To address education and training providers, ESSA uses national databases, email marketing, the ESSA partner network, website, career offices in education institutions, etc. One important point is to localise the key results and materials for more efficient uptake across the EU member states.

EU-wide campaigns will be deployed in 2023 and 2024 to reach this target groups with the aim to:

- Stimulate the adoption of the VET curricula, training programmes, and materials
- Ensure training supply is available to fill current and future roles on the labour market

6.5.2.3 Addressing potential learners

Bringing the benefits and results of the ESSA project to EU citizens is one of the goals of the Alliance — they are as well the end-beneficiaries. It is important to work with schools and school networks to promote software educational pathways at an early age, as well as to work with recruitment agencies and employment services to support individuals who want to re/upskill.

EU-wide campaigns will be deployed in 2023 and 2024 to reach this target groups with the aim to:

- Promote Software as a career choice to create a demand for software jobs
- Present the career pathways
- Ensure available training spots are filled

6.5.3 Build a Software Skills Community

The Software Skills Community space provides an engaging collaboration platform for all software stakeholders including small to large-sized ICT organisations, education and training providers, professional associations, individual software professionals and

policymakers. The community provides a key environment to ESSA itself and as a whole; enabling stakeholders to act as a network, share knowledge and insights, increase their visibility, identify trends, and advocate all together for software skills and professional quality.

6.6 Strategic objective 6. Foster cooperation and ensure sustainability.

The ESSA Alliance fosters transnational cooperation and builds on stakeholder networks throughout the project lifecycle. The overall objective of this collaboration is to continuously research, identify and analyse the skills requirements of the European software sector, and then create and iteratively improve the Software Skills Strategy to develop innovative VET training programmes that will address the short, medium, and long-term needs of the sector, including emerging needs and new technologies and techniques that are currently being developed.

The Alliance includes a core partnership of 21 organisations (Full Partners), 5 supporting organisations (Associated Partners) across 12 European countries. Additional stakeholders and partners will be added from all EU countries and beyond, during and after the project. The growing ESSA Alliance will foster cooperation and ensure sustainability by broad collaboration, namely:

- An annual programme of online and offline meetings, networking and collaboration between ESSA members.
- Online networking and collaboration within the Alliance via private discussion groups and video calls.
- One large Stakeholder Conference in 2024 for the wider software sector stakeholder group.
- An online European Software Skills Community will be established in 2022 to facilitate broad stakeholder engagement from across Europe.

Main target groups involved: Education, training, accreditation and certification providers, Organisations with demand in software skills, Potential learners, EU and national policymakers, and Social partners, chambers, networks, associations, and umbrella organisations.

Key topics covered: cooperation, sustainability, mobility programme, European dimension, associated partners, project results.

Roadmap:

Foster cooperation and ensure sustainability	ESSA PERIOD				POST ESSA		
	2021	2022	2023	2024	2025	2026	2030
Develop European mobility programmes		European mobility programme		Sustainability of the mobility programme			
Create an ESSA network of associated partners		Network of associated partners			Sustainability of the ESSA network		
Ensure sustainability of main project results		Elaboration and dissemination of project outcomes			Sustainability of project outcomes		

6.6.1 Develop European mobility programmes

The curricula and training programmes will be designed to be future proofed and easily transferable to other countries. The Software Skills Strategy will serve as a basis to analyse skills and market needs for software services occupations and recommendations for modernising education, especially in the area of VET and higher VET. Developed

throughout the lifecycle of the project, standards and guidelines for software services occupational professions will be transferable across EU countries and their educational and accreditation systems. As the learning outcomes-based curricula will be adopted or created in partnership with education and training institutions/provides and the industry, the industry-led certification will be related into standard accreditation process for this particular curriculum. This industry relevance is a key as it offers a common language and facilitates the comparison of different qualifications awarded, it is highly recognised by employers, and it will ensure the strategy keeps up with the rapid pace of technology innovation.

6.6.1.1 Cross-border mobility

The cross-border mobility will be improved by the fact that educational profiles with learning outcomes will be receiving European recognition. One way of doing this is to define profiles and learning outcomes that are formulated in such a way that they can be matched with nationally accredited programmes. This makes it far easier to validate skills and competences of people educated in one country in another country.

In the project plan ESSA already announced and defined a project outcome on a European mobility programme. This is not strictly focused on education and training but viewed as an important aspect for the success of ESSA.

6.6.1.2 Language skills

A specific point of attention that came forward during the needs analysis is that English is asked for a lot, but also for the local language of the employer. This causes mobility issues, because it is not feasible for all software professionals to learn a very wide variety of European languages. It is of course possible to incorporate English language skills for software professionals in the educational profiles. Local languages in general will be a point of attention in the mobility programme and can be the topic of upskilling training.

6.6.1.3 Modularity of the curricula

The modularity of educational programmes is an important tool for efficient, up to date skilling, reskilling and upskilling. The first advantage of modular programmes is that it is easier to replace or update parts of the programme without having to redesign the whole programme. Educational profiles will be formulated in a way that they will remain stable in most cases. In a profile, for example, there will be no specific programming language prescribed, so that it won't change when a new programming language is becoming more popular. A learning provider can decide to replace a module in an educational programme and replacing one programming language by another.

6.6.2 Create a network of associated partners

The European Software Skills Alliance (ESSA) offers the possibility to become an ESSA Associated Partner and be part of different project work strands with a view to establishing long-term and mutually beneficial cooperation. Since 2022, the ESSA Alliance will be in continuous growth to ensure long-term sustainability of the Alliance after the ESSA Project finalisation.

ESSA Alliance welcomes any kind of organisation: public and private organisations of all sizes, all kinds of learning providers, accreditation and certification providers, social partners, chambers of commerce, and other associations. Each associated partner will get involved in different work strands and collaborate with the ESSA Alliance with different levels of commitment and dedication that each associated partners will have to agree and make it

formal by agreeing a Memorandum of Cooperation. The cooperation in the context of the ESSA Alliance is based on the principles of common interest and complementarity.

6.6.3 Ensure sustainability of main project results

In order to ensure sustainability and long-term impact of the training programmes after the project ends, the ESSA Alliance will define standards and criteria for the software skills programme that ensures it matches closely with e-CF and related standards and frameworks used by subject specific accreditation agencies, thus creating benchmarks to measure the training programmes against.

The ESSA Alliance long-term sustainability plan for the continuous roll-out of activities after the project finalisation will include a strategy for the ongoing expansion of the Alliance, continuous annual improvements of the Skills Strategy, the updating and scaling of VET Curriculum and Training Programmes, the ongoing rollout of the Communication Strategy to ensure EU wide adoption of the VET training and promote software as a career, and the identification and exploitation of EU funding opportunities to ensure financial viability.

The ESSA Alliance long-term sustainability strategy will ensure the rollout of the project outcomes and achievements beyond the project duration. The sustainability will rely on two main activities:

- The creation of a sustainable ESSA Alliance composed by a wide number of associated partners representing all EU countries and beyond, that operates as a volunteer industry stakeholder group.

- The active search of EU funding to continue the promotion and localisation of main ESSA project outcomes and to support the management of the ESSA Alliance after the ESSA project finalisation.

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7. Conclusions

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7 Conclusions

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

Strategic objective 1. Map, analyse and monitor skills needs. The ESSA Alliance needs analysis focused on a first inventarisation and mapping of the skills needed for software professionals. The ESSA Alliance strategy review process continues this process and will provide an overview of the future and current demand for skills and role profiles for software professionals on a yearly basis. An important part in this process is the involvement of experts by means of expert groups, organised at national levels and European level. In this way, the expert groups function at the same time as a carriage to involve stakeholders and foster essential partnerships, embedding ESSA's activities in local contexts.

Strategic objective 2. Identify market-oriented software roles. The ESSA Alliance 5 selected professional role profiles for software professionals are evaluated given the current and projected market needs and adapted when relevant. Results from the needs analysis clearly indicated the importance of certain soft skills and profession-related skills in relation to all the selected software roles.

Strategic objective 3. Design and develop harmonised curricula. The ESSA Alliance harmonised curricula will be consistent and market-oriented. Therefore, a translation of market needs to educational concepts is necessary, which can be done by using educational profiles. There are several aspects that are important when looking at effectively and efficiently educating and training of software professionals like flexibility and modularity which directly link to individualised pathways and the recognition of earlier acquired skills. . Part of the development of these curricula are also the development of learning materials and the piloting of the curricula.

Strategic objective 4. Validate learning processes. The ESSA Alliance will focus on independent assessments of learning outcomes using professional assessment organisations. ESSA will develop an accreditation system for the learning programmes and a certification framework for skills for software professionals, based on the principles of micro credentialling and making use of digital badges.

Strategic objective 5. Boost awareness and stakeholder engagement. The ESSA Alliance designs, plans, and implements communication and dissemination activities oriented towards specific target groups involved in the ESSA activities and its ecosystem. The ultimate objective is the creation of a Software Skills Community enabling stakeholders to act as a network, share knowledge and insights, increase their visibility, identify trends, and advocate all together for software skills and professional quality.

Strategic objective 6. Foster cooperation and ensure sustainability. The ESSA Alliance fosters transnational cooperation and builds on stakeholder networks throughout the project lifecycle. The overall objective of this collaboration is to continuously research, identify and analyse the skills requirements of the European software sector, and then create and iteratively improve the Software Skills Strategy to develop innovative VET training programmes that will address the short, medium, and long-term needs of the sector, including emerging needs and new technologies and techniques that are currently being developed.

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Annex Glossary

This glossary provides a list of key terms that are used thereinafter and their definitions for the purposes of this document. 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	Type of learning programme, based on a predefined selection and organisation of content, offered in a certain way by an educational institution, such as a school, college, or university. (CEN/TC 428, TS 17699, 2022)
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)
European Skills, Competences, Qualifications and Occupations (ESCO)	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)
Formal education	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)
Formal learning	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)
Formal recognition (of learning outcomes)	Process of granting official status to learning outcomes knowledge, skills and competences either through:

· validation of non-formal and informal learning;

· grant of equivalence, credit units or waivers;

· award of qualifications (certificates, diploma or titles). (Cedefop, 2014)

Hard skills	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)
Higher or upper VET	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)
ICT Body of Knowledge (ICT BoK)	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)
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	Coherent set of learning activities with the aim of providing learners with certain knowledge, skills or behaviour over a certain period of time. (CEN/TC 428, TS 17699, 2022)
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 competencies 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	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: • definition of qualification policy, training design and implementation, institutional arrangements, funding, quality assurance; • assessment and certification of learning outcomes. Comment: a national qualifications system may be composed of several subsystems and may include a national qualifications framework. (Cedefop, 2014)
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). |

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