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E-competences and IT professionalism

ESCO for All: An Inclusive and Intelligent Platform for Exploring Digital and Professional Competences

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ABSTRACT

The ESCO framework is vital for enhancing transparency in EU labour and education systems, but its complexity can limit accessibility. To address this, we introduce 'ESCO for All,' a user-friendly web and mobile platform built with Spring Boot, React, and Ionic, deployed on Azure with full CI/CD pipelines. It features an intelligent semantic search engine powered by embeddings to enhance the discoverability of skills and occupations. The platform includes social features like discussion forums, user profiles with skill tracking, and data analytics dashboards for administrators. Developed using agile methodologies across four iterative sprints, 'ESCO for All' provides a sustainable, accessible, and scalable solution to boost digital competence and professional development across Europe.

Keywords: ESCO, Digital Competence, Skills, Career Development, Inclusive Design

INTRODUCTION

The European Skills, Competences, Qualifications and Occupations (ESCO) framework [1], initiated by the European Commission, seeks to achieve harmonisation in the description of skills and occupations across EU member states. The objective of this programme is threefold: firstly, to promote lifelong learning; secondly, to provide career guidance; and thirdly, to facilitate labour mobility. ESCO has categorized vast array of skills, competencies, qualifications and job titles, thereby providing a unified language for employers, educators and job seekers throughout the European labour market. However, despite its strategic value, the framework is

underutilised due to its complex data structures, lack of integration into everyday digital tools and absence of intuitive user interfaces tailored for non-technical users.

In an era where digital inclusion and competence development are critical, there is a pressing need for accessible tools that can translate complex datasets into actionable insights. The 'ESCO for All' initiative directly addresses this issue head on by offering a user-centric, multilingual and interactive platform that facilitates a paradigm shift in the way users engage with ESCO data. By simplifying access and enabling meaningful interaction with professional and educational taxonomies, the platform fosters better career planning, digital literacy and workforce alignment.

Furthermore, the project aligns with key European initiatives, such as DigComp [2], which emphasises the importance of digital skills for all citizens, and the European e-Competence Framework (eCF) [3], which promotes standardised descriptions of IT professional capabilities. The solution proposed herein serves to address the aforementioned discrepancy by establishing a conduit between existing policy frameworks, such as Europass, and practical, accessible tools for implementation in educational and professional contexts.

BACKGROUND

To develop this project, it was first necessary to conduct a preliminary study of several key elements. The following section provides a concise overview of two of these: the ESCO framework, upon which the project will be based, and the ESCO-GPT tool, which will facilitate the incorporation of an external NLP-based search engine.

ESCO

The European Skills, Competences, Qualifications and Occupations (ESCO) framework [1], developed by the European Commission, is a multilingual classification system designed to standardise descriptions of skills, competences, qualifications, and occupations across EU member states. This initiative launched with the objective of enhancing labour market transparency and mobility, ESCO provides a common language that connects employers, educators, and job seekers by categorising over 13,000 skills and 3,000 occupations. It supports critical European initiatives, such as the Europass platform and the Digital Competence Framework (DigComp), by enabling better alignment between education systems and workforce needs, fostering lifelong learning, and facilitating cross-border career opportunities.

Despite its comprehensive scope, ESCO's complex data structures and technical nature can pose challenges for non-expert users, such as educators, students, and job seekers, limiting its

practical adoption. The framework's potential to bridge gaps in career guidance and skill development remains underutilised without intuitive, accessible tools. Addressing this gap, innovative platforms are required that can translate ESCO's extensive dataset into user-friendly interfaces. The purpose of these platforms is to empower diverse audiences to explore and apply its resources effectively, thereby enhancing digital literacy and professional development across Europe.

ESCO-GPT

To facilitate the identification of skills through the utilisation of language analogous to that employed by the user, the ESCO-GPT tool [4] has been employed. This tool uses natural language processing (NLP) techniques to help users find the ESCO skill that most accurately aligns with their description. To ensure a greater flexibility in the searching process, the tool provides a list of up to ten related skills.

To enable the utilisation of the tool across a range of applications, it has been equipped with a REST API¹, thereby ensuring ease of use. In the developed project, this feature was used to give the final project this skills search functionality, enabling users to adapt their CVs to the ESCO language.

METHODOLOGY

The development of "ESCO for All" followed agile principles, adopting the Scrum methodology [6] to manage tasks and iterations efficiently. Each sprint focused on incremental goals, starting the establishment of technical infrastructure and user authentication, followed by the implementation of ESCO-related functionalities, social interactions via forums, and finally, data analytics and automated deployment. The implementation of daily stand-up meetings resulted in the facilitation of communication and rapid of obstacles to productivity, thereby facilitating the effective resolution of issues.

User-centered design, guided by agile principles [5], was a priority throughout the project. The creation of mockups and wireframes was undertaken to validate the usability of the interface with potential users. Feedback from early users was integrated into subsequent iterations. It is evident that particular emphasis was placed on accessibility (WCAG compliance [6]), multilingual support, and responsive design to ensure inclusiveness and wide adoption.

¹ <http://xsystem.cc.uah.es>

The project was deployed using contemporary DevOps practices, with GitHub Actions overseeing CI/CD pipelines for both frontend and backend components. This approach enables the rapid and reliable delivery of new features.

RESULTS

The "ESCO for All" platform is distinguished by a set of integrated features designed to enhance the user experience, support personal and professional development, and promote collaborative learning.

- **Semantic Skill Search:** The platform is underpinned by a semantic search engine based on embeddings [7], which enables users to find relevant ESCO skills and occupations even in cases where terminology is imprecise or non-standard. This enhancement in accessibility is particularly beneficial for users who unfamiliar with formal classification structures.
- **Personal Skill Portfolios:** Registered users have the capability to construct and manage their own profiles by correlating themselves with ESCO competences. This portfolio can be used for self-assessment, career planning, or as input for educational programmes.
- **Occupation Explorer:** Users can browse occupations and explore the essential and optional competences associated with them. The system suggests suitable roles based on the user's selected competences, facilitating vocational orientation.
- **Forums and Social Interaction:** A forum system facilitates the creation of discussion threads, enables users to participate in existing conversations, and allows them to share insights on skill development, job opportunities, or educational resources. This fosters a collaborative learning environment and promotes community participation.
- **Multilingual and Inclusive Design:** The platform supports multiple languages (initially Spanish, English, and Portuguese) and adheres to WCAG standards for accessibility, ensuring usability for diverse user groups.
- **Administrative Analytics Dashboard:** Administrators have access to analytics dashboards that presents the usage statistics, most searched competences, and trends across different user segments. This supports informed decision-making and facilitates continuous improvement.
- **Exportable Data Reports:** Users and administrators can export data in CSV or Excel format, thereby enabling offline analysis, reporting, or integration with other systems.

Figure 1. Web appearance



Collectively, these features transform ESCO from a static classification system into a living, interactive environment where users can discover, reflect upon, and engage with the skills landscape in Europe.

The development yielded a fully functional and responsive Web application that met all initially defined objectives. Test users provided feedback of an exclusively qualitative nature, in which they highlighted the ease of use, clarity of the interface, and the usefulness of the semantic search and occupation matching. The integration of real-time data analytics enabled administrators to monitor platform engagement and identify high-interest competences.

From a technical standpoint, the CI/CD pipeline has been shown to streamline updates and deployments, reducing time-to-delivery and improving software reliability. The implementation of automated tests and containerization ensured consistent behaviour across diverse environments.

The project demonstrated robust alignment with digital competence frameworks and received favourable commentary regarding its potential impact in educational and career development settings. The groundwork established thus far will serve as a basis for future iterations, including the development of advanced recommendation systems and interoperability with Europass and other European digital credential systems.

CONCLUSION

The "ESCO for All" framework is a case study in the use of a technically robust and pedagogically sound platform to facilitate engagement with complex skill classification systems such as ESCO. The integration of contemporary web and mobile technologies with user-centred

design and agile development, has resulted in the delivery of a solution that is both functional and forward-looking.

The platform has been demonstrated to enhance the accessibility and usability of ESCO data, with encouraging results regarding its integration into educational curricula, career guidance programs, and upskilling initiatives. The integration of semantic search and intuitive design fosters accessibility for users with diverse digital proficiency levels, encompassing educators and students to career counsellors and job seekers.

The future direction of the project will include the implementation of personalised recommendation engines, the expansion of supported languages, deeper integration with the Europass framework, and incorporation of digital badges or credentialing mechanisms. The execution of additional evaluation studies encompassing a more extensive range of user demographics, could serve to provide further validation impact, whilst concurrently providing a framework for the systematic implementation of iterative improvements.

Ultimately, "ESCO for All" has been identified as a key factor in facilitating the alignment between EU digital policy frameworks and the practical digital tools that empower individuals and institutions across Europe.

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How NLP can enrich EN16234 and link it to the ESCO classification

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Abstract

This paper analyses some useful enhancements to the European e-Competence Framework (standard EN16234) to complement its textual content so additional valid information could be available for supporting its application in real practice. This work identifies some missing details either not considered in standard text or not explicitly mentioned in it although they could be extracted from the document. Given the large amount of information and the complexity of relationships among items, only Natural Language Processing (NLP) enables a feasible work for adding more pragmatic and complete information to e-CF while also enabling a real alignment and mapping to ESCO.

INTRODUCTION

In the rapidly evolving digital economy, skills frameworks play a crucial role in providing a structured way to describe, assess, and develop ICT professional competences [1]. These frameworks act as a common language to guide education providers [2], employers [3] and policymakers, enabling consistent communication and interoperability across countries and industries. Their standardized descriptions of competences, skills, and knowledge facilitate mobility, workforce planning, and lifelong learning initiatives contributing to the ICT professionalism [4]. The two most relevant frameworks for ICT occupations in the EU are the standard EN16234 e-Competence Framework [5] and the EU labour classification ESCO [6].

The e-Competence Framework

EN16234 [6], commonly known as e-CF, is a framework that provides a common language for the competences required and applied by Information and Communication Technology (ICT) professionals. It is organized into five competence areas and four dimensions and supports varied stakeholders such as HR experts, education centres, and policymakers. While the e-CF offers a

good structure for ICT competences, its current version still misses some pragmatic details and connections to other labour taxonomies, thus hindering its applicability in some contexts.

The European Skills, Competences, Qualifications and Occupations (ESCO)

ESCO is the multilingual classification of skills, competences, qualifications, and occupations maintained by the European Commission [6]. It provides detailed and structured vocabulary that supports the matching of people to jobs and learning opportunities across Europe. Its use is compulsory in all Member States of the EU since 2021. ESCO has around 14,000 skills and knowledge items linked to 3,039 occupations in all sectors (103 for ICT). Its broad coverage and labour market relevance, its official recognition as terminology in the EU and its official multilingual availability make it an ideal asset for enriching other frameworks such as e-CF.

Objectives of the Paper

The aim of this paper is to show the points of e-CF which could be enhanced and complemented for its better pragmatic understanding and application in practice. Given the amount of information and the complexity of the relationships among items, mere manual methods are not feasible. So, NLP and text mining techniques arise as logical and natural solution to add explicit practical details to enrich e-CF, while also establishing a robust link to ESCO: this addresses the gap between a high-level competence framework (e-CF) and the rich and granular data of ESCO, more practical and actionable. So, the expected contributions of this paper are the following:

RG1: Identification of improvable details either missing or weakly defined within e-CF as well as the possibilities of mapping and linking it to ESCO.

RG2: Show examples of how NLP can assist in improving the identified weak points.

IDENTIFYING MISSING POINTS IN EN16234

The standard EN16234 has proven to be a valuable reference for describing ICT professional competences in a standardized and widely accepted way. However, despite its strengths, the framework presents some notable gaps that limit its full practical potential. These missing elements, if addressed, could make e-CF more descriptive, actionable, and aligned with other European skills taxonomies such as ESCO.

Figure 1 illustrates one of the e-Competences from the e-CF framework (A.2) with the identification of some of the missing points within the framework.

Figure 1 Missing points in e-CF e-Competences

Dimension 1 e-Comp. area	A. PLAN					No description of areas for Dim 1
Dimension 2 e-competence: Title + generic description SHALL APPLY	A.2. Service Level Management Defines, validates and makes applicable service level agreements (SLAs) and underpinning contracts tailored to services offered. Negotiates service performance levels taking into account the needs and capacity of stakeholders and business.					No link between action/responsibility phrases and the required proficiency levels
Dimension 3 e-Competence proficiency levels e-1 to e-5, related to EQF levels 3 to 8 SHALL APPLY	Level 1	Level 2	Level 3	Level 4	Level 5	No link between S/K examples and proficiency levels
	--	--	Ensures the content of the SLA.	Negotiates revision of SLAs, in accordance with the overall objectives. Ensures the achievement of planned results.	--	
Dimension 4 Knowledge examples Knows/ aware of/ familiar with MAY APPLY	K1 SLA documentation K2 how to compare and interpret management data K3 elements forming the metrics of service level agreements K4 how service delivery infrastructures work K5 impact of service level non-compliance on business performance					The number of S/K examples are limited to 4 to 10
Skills examples Is able to MAY APPLY	S1 analyse service provision records S2 evaluate service provision against SLA S3 negotiate realistic service level targets S4 use relevant quality management techniques S5 anticipate and mitigate against potential service disruptions					No more information for each S/K (e.g., description, links to occupations, etc.)

Dimension 1 consists of the five competence areas (Plan, Build, Run, Enable, Manage), each serving as a high-level thematic category for ICT competences. In the current version of the e-CF, each area is listed only by its title, without explanation of its scope, boundaries, or intended coverage. Adding a short descriptive paragraph for each competence area would clarify the conceptual differences among areas, helping to correctly classify competences.

Dimension 2 contains the list of e-Competences, each with a title and a description made up of phrases that express actions and responsibilities. While this provides useful qualitative insight, there is no explicit link between these action/responsibility phrases and the proficiency levels for each phrase although a simple inspection reveals all the statements are general but related to different levels. For example, the description for A.1. Information Systems and Business Strategy Alignment includes the phrase: *“Anticipates long term business requirements, influences improvement of the organisation’s process efficiency and effectiveness...”*. However, the

framework does not specify the link to proficiency level 3, 4, or 5. This deficit makes it difficult to accurately assess or self-assess levels and to map to job descriptions with proficiency thresholds.

Dimension 4 provides non-exhaustive lists of illustrative examples of knowledge and skills for each e-Competence. The number of examples is limited, often between 4 and 10 items: while valuable, this narrow coverage and the lack of definition of the terms can leave out important aspects of a competence thus making more difficult their identification in real practice.

One additional consideration involves the set of role profiles presented in Annex B7.2 of the e-CF standard which describes 30 ICT role profiles mentioning the 5 most relevant e-Competences (**Table 1**). This information deserves a comparison with the corresponding ESCO equivalent occupations aligned with each role. This would not only align the e-CF profiles with the full ESCO classification but would also facilitate better interoperability and enriched profiles at both sides.

Table 1 Similar profiles in Annex B7.2 of e-CF and ESCO

ICT PROFILES	EN 16234-1:2019 Annex B.7 profile	ESCO Occupation Profile
TITLE	Chief Information Officer Role (4)	Chief information officer
Summary statement	Develops and maintains Information Systems to generate value for the business and meet the organisation's needs.	Define and implement the ICT strategy and governance. Determine necessary resources for ICT strategy implementation, anticipate ICT market evolutions and company business needs. Contribute to the development of the organisation's strategic plan and ensure that ICT infrastructure supports the organisation's overall operations and priorities.
e-Competences (e-CF) or Skills and Knowledge (ESCO)	A.1. IS and Business Strategy Alignment -L.5 A.3. Business Plan Development - L.5 E.2. Project and Portfolio Management - L.5 E.4. Relationship Management - L.4 E.9. Information Systems Governance - L.5	Essential skills and competences (14) Coordinate technological activities Define technology strategy, etc. Essential knowledge (8) DSS, ICT project management methods, etc. Optional skills (10) and knowledge (15)

THE ROLE OF NLP IN ENHANCING THE E-CF

This section outlines the challenges of manual processes and how NLP is a solution in this context with its techniques for handling the linguistic and semantic complexity of large skills frameworks.

Challenges for the process

Skills frameworks like e-Cf and ESCO (strictly a labour classification) contain very large datasets. ESCO alone includes about 14000 skills and knowledge examples of which 1,238 are associated

with 103 occupations of ISCO codes 133 (“Information and Communications Technology Service Managers”: 12 profiles), 25 (“Information and Communications Technology Professionals”: 69 profiles), and 35 (“Information and Communications Technicians”: 22 profiles). On the other side, e-CF has 41 e-Competences in 5 areas with 278 knowledge examples (6.78 average per each competence) and 245 for skills (average of 5.97 per competence). Comparing them with the 1,238 ICT-related items in ESCO implies exploring 647,474 potential connections. The possible links of 523 skills and knowledge examples to the five proficiency levels of e-CF results in 2,615 possible combinations. The number of relations is 785 for the 157 statements in dimension 2 of e-CF. Manual analysis would mean significant challenges without using automated methods such as NLP-based semantic similarity analysis: huge time and effort by expensive experts, proneness to inconsistency and difficult update in response to changes. NLP enables to process, classify, and cross-reference such datasets in less time with wider coverage and faster iterations.

NLP Methodology

The primary data sources are the textual contents of the e-CF and ESCO frameworks, both stored in structured CSV format. Each CSV file organizes the textual elements in a tabular form to facilitate automated processing. **Table 2** illustrates a portion of the e-CF textual dataset. Each row corresponds to one e-Competence, while the columns show related information: title, description, statements in the proficiency levels, and other relevant attributes.

Table 2 a portion of the e-CF textual dataset

Dimension 1	Dimension 2	Description of Dim2	Dimension 3 (Proficiency level)	...
A. PLAN	A.1. Information Systems and Business Strategy Alignment	Anticipates long term business requirements, influences improvement of the organisation’s process efficiency and effectiveness. Determines the IS model and enterprise architecture maintaining consistency with organisational policy and ensuring a secure environment....	Level 4. Provides leadership for the construction and implementation of long term innovative IS solutions. Level 5. Provides IS strategic leadership to reach consensus and commitment from the management team of the enterprise.	...
⋮	⋮	⋮	⋮	⋮
B. BUILD	B.1. Application Development	Interprets the application design to develop a suitable application in accordance with customer needs. Adapts existing solutions by e.g. porting an application to another operating system. Codes, debugs, tests and documents and communicates product development stages...	Level 1 Acts under guidance to develop, test and document applications. Level 2 Systematically develops and validates applications. Level 3 Acts creatively to develop applications and to select appropriate technical options....	...
⋮	⋮	⋮	⋮	⋮

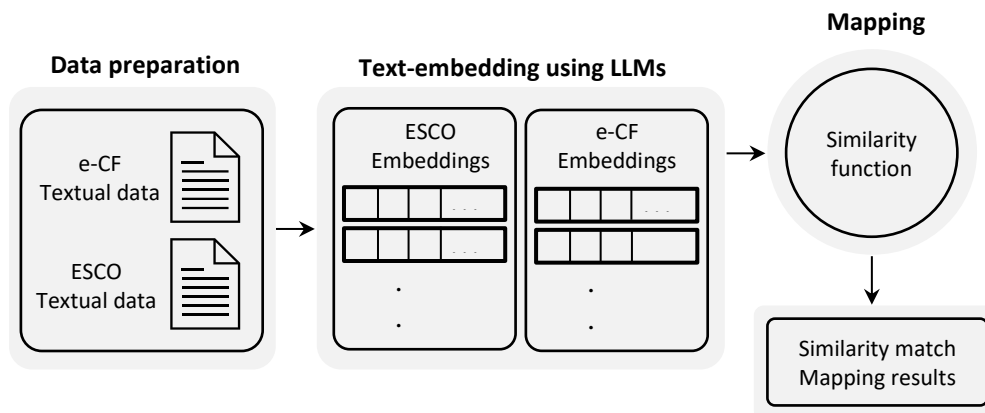
Table 3 presents a sample from the ESCO skills dataset: each row has one skill, from the total of 13890 in version 1.2, with its description, alternative labels, hidden labels, and other metadata.

Table 3 A portion of the ESCO textual skills dataset

Skill	Alternative Labels	Hidden Labels	Description
ICT project management methodologies	Agile, Prince2, Scrum, Software development methodologies, Structured methodology, etc.	Kanban, Extreme project management, etc.	The methodologies or models for planning, managing and overseeing of ICT resources in order to meet specific goals, such methodologies are Waterfall, Incremental, V-Model, Scrum or Agile and using project management ICT tools.
Perform backups	Backup data, Backup ICT system		Implement backup procedures to backup data and systems to ensure permanent and reliable system operation. Execute data backups to secure info by copying and archiving to ensure integrity during system integration and after data loss occurrence
⋮	⋮	⋮	⋮

Text embedding and semantic similarity [7] can link and map the e-CF competences to ESCO skills. The process starts by converting the text from both frameworks into vector representations (embeddings) using a pre-trained Large Language Model (LLM). Once encoded, similarity functions (e.g., cosine similarity) compare the embeddings. This identifies rows from each CSV file that are semantically closest to one another. **Figure 2** illustrates this mapping process, showing a subset of e-competences and their similar ESCO skills detected by the NLP model.

Figure 2 Linking e-CF dimensions to ESCO (Methodology)



ILLUSTRATIVE EXAMPLES OF NLP FOR SKILLS AND KNOWLEDGE MAPPING

This section presents illustrative examples of how the mentioned NLP with text embedding techniques with semantic similarity functions creates meaningful mappings between e-CF and ESCO. The mappings can be established in both directions by analysing the textual content of e-CF competences and systematically identifying their closest matches within ESCO database: from e-CF to ESCO (Example 1), and from ESCO back to the examples of e-CF Dimension 4 (Example 2).

Example 1: ESCO Skills and Knowledge as valid examples for an e-CF Competence

Each e-CF competence is mapped to its semantically closest ESCO skill items using text embeddings and similarity scores. For example, consider the e-CF competence “A.4. Product/Service Planning” focused on defining and evaluating requirements for new or improved products and services, considering business objectives and customer needs. **Table 4** presents the 20 ESCO skills that are most similar to A.4, selected from the total of 13890 skills in ESCO.

Table 4. Top 20 ESCO skills linked to the e-Competence A.4 “Product/ Service Planning” in e-CF

ESCO skills for A.4	Similarity	ESCO skills for A.4	Similarity
develop business plans	0.678218126	manage budgets	0.613298178
analyse business plans	0.672842741	business requirements techniques	0.612357616
perform product planning	0.668557167	review development process of an organisation	0.597656608
develop company strategies	0.654132366	manage ICT project	0.59484601
develop strategy to solve problems	0.633840561	analyse supply chain strategies	0.589193463
implement operational business plans	0.632507801	identify customer's needs	0.589106798
strategic planning	0.625448287	project management	0.589060009
organisational structure	0.623183489	lead the brand strategic planning process	0.588921189
implement strategic management	0.616581321	ICT project management methodologies	0.587889314
perform resource planning	0.614461422	prepare purchasing reporting	0.587787032

Each ESCO skill entry includes a textual description, a list of alternative labels (synonyms or related terms) and links to the occupations requesting it. This information adds benefits to e-CF.

- e-CF competences are enriched with descriptions and multilingual support of around 20 examples instead of the previous 6.78 and 5.97 average knowledge and skills items.
- Improving contexts with ESCO occupations linked to each e-competence through skills and knowledge with more searchability by adding terminology with more likely matches.

Example 2: ESCO items most similar to each specific example in Dimension 4 of e-CF

The same NLP methodology can be used in reverse direction to enrich Dimension 4 of the e-CF. This dimension includes illustrative examples of knowledge and skills relevant to each e-Competence. However, those examples are a limited set of expressions without description or definition. For example, considering the e-competence E.1. “Forecast Development”, each of the four knowledge examples and five skill examples in Dimension 4 can be mapped to multiple relevant items in the ESCO dataset by applying semantic similarity analysis. **Table 5** illustrates

such a mapping for E.1. “Forecast Development”, showing several ESCO skill items that correspond closely to the skills listed in Dimension 4.

Table 5 a portion of equivalent ESCO skills to Knowledge examples and skills in Dimension 4 in e-Cf

E.1. Forecast Development		
Dimension 4 – E.1	ESCO equivalent	Similarity
K1 market size and relevant fluctuations	market analysis	0.383480966
	track price trends	0.352810174
	game theory	0.341518104
	develop statistical software	0.314282238
	perform market research	0.31278944
	:	:
K2 accessibility of the market according to current conditions (e.g. government policies, emerging technologies, social and cultural trends, etc.)	market analysis	0.5314973
	develop company strategies	0.507404685
	product life cycle	0.486937314
	identify technological needs	0.475429267
	ICT market	0.46562624
	:	:
:	:	:

This mapping enriches the dimension 4 of e-Cf as each ESCO item comes with detailed descriptions, alternative labels, multilanguage translation and occupational links, providing substantial added value. Furthermore, each knowledge or skill example in Dimension 4 is now linked to multiple ESCO entries, enriching its understanding. At the same time, linking e-CF to ESCO provides consistency with labour market data (e.g., from EURES¹ and OVATE²) and enables data-driven updates, continuously leading to direct changes in mappings.

CONCLUSIONS AND FUTURE WORKS

This paper has shown how NLP techniques create semantic links between two major European frameworks: e-CF and ESCO. e-CF competences can be enriched with detailed, validated examples of skills and knowledge from ESCO by using text embedding and similarity analysis. This approach addresses key limitations in e-CF, by expanding its content with concrete, multilingual, and labour market-aligned information. It also allows the addition of missing descriptions where only labels existed, enhancing the use of e-CF in profiling tools, and enabling direct integration with EU labour market platforms. So, the enriched e-CF becomes more pragmatic and powerful.

Future work will focus on scaling and completing this approach in all weak points identified in e-CF: e.g., defining proficiency levels for all ICT skills and knowledge items in the ESCO classification

¹ https://eures.europa.eu/index_es

² <https://www.cedefop.europa.eu/en/tools/skills-online-vacancies>

thus allowing systematic comparisons between e-CF competence profiles and the corresponding occupation profiles in ESCO. It will also include exploitation of ESCO-linked datasets (e.g., OVATE and EURES) for dynamic, real-time connections with e-CF competences. In the end, all these developments could then support tools/platforms for semi-automated mapping, allowing experts to validate and refine NLP-generated links leading to enhanced competence profiling, better training and career systems, and ongoing alignment with evolving market demands.

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AICA Assessment for the Digital Decade

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ABSTRACT

This article presents a digital skills assessment tool developed by AICA to address the need for designing training that can enhance the digital skills of the population. The authors frame the initiative within the context of the "Digital Decade" and the surveys indicating that, throughout Europe, but particularly in Italy, the proposed targets for the population's basic digital skills are still far from being met.

Keywords: Digital skills, Digital Decade, DESI, Skills assessment, Skills Observatory

INTRODUCTION

Based on the European Commission's Communication of March 9, 2021, "2030 Digital Compass," which outlines a vision for an inclusive, sustainable, secure, and citizen-centric digital transformation, Decision (EU) 2022/2481 established the **Digital Decade Policy Programme 2030** in 2022 [1]. The overall goal is to ensure a digital transformation of the European economy and society that respects fundamental rights, inclusion, sustainability, digital sovereignty, and transparent governance.

Figure 1. The 4 Pillars of the Digital Decade (from cited Digital Decade Policy Programme).

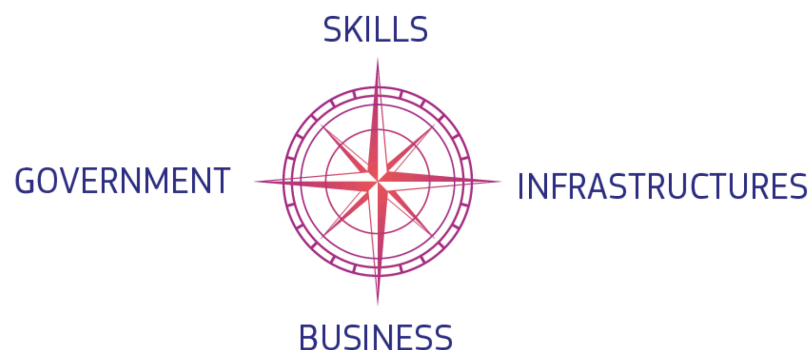


Figure 1 highlights the four pillars of the plan [2]: **Skills (ICT specialists & Basic digital skills)**, **Secure and sustainable digital infrastructures**, **Digital transformation of businesses**, and **Digitalization of public services**.

For each pillar, measurable quantitative targets are defined. For the first pillar:

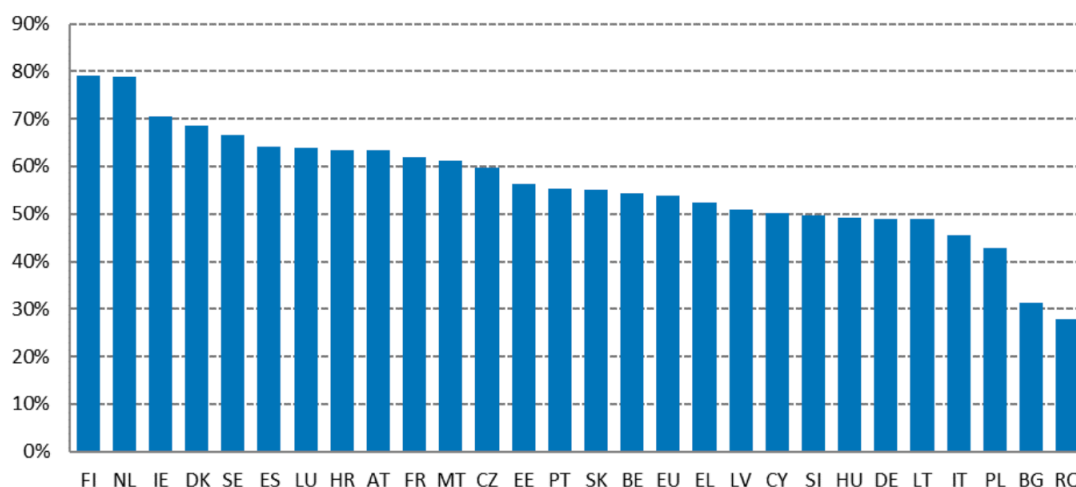
- **Basic skills:** By 2030, at least 80% of the European population aged 16 to 74 must possess at least basic digital skills.
- **ICT specialists:** The goal is to reach 20 million employed ICT specialists, with a better gender distribution.

In this article, we will look at the first objective: digital competence, which is one of the 8 key competences. The DigComp framework has clarified that it is not a single competence but a set of 22 competences. We will also illustrate how AICA, the Italian computer science association and a member of CEPIS and the ICDL Foundation, is working to identify skill gaps to enable the design of targeted training interventions and, subsequently, certify the acquired skills.

DIGITAL SKILLS: THE SITUATION

When the Digital Decade plan was formulated, the DESI 2021-2022 index reported: *"While 87% of people (aged 16-74) used the internet regularly in 2021, **only 54% possessed at least basic digital skills**. The Netherlands and Finland are the frontrunners in the EU, while Romania and Bulgaria are lagging behind. A large part of the EU population still lacks basic digital skills, even though most jobs require such skills"* [3].

Figure 2. At least basic digital skills (% of individuals), 2021.



Source: Eurostat, European Union survey on the use of ICT in Households and by Individuals

Regarding Italy, the situation was among the worst, at around 45%, just above Romania, Bulgaria, and Poland.

In the context of the Digital Decade initiative, the European Commission recently published the **State of the Digital Decade 2024** [4] and reports on individual EU countries. It notes that the target for basic digital skills has so far only been met at 69%, meaning that as of today, only 55.2% of the European population possesses them. Therefore, the increase has been minimal so far.

For Italy, the *Italy Country Report* [5] highlights that *"In 2023, Italy made progress in the e-government sector, particularly with e-health and key digital public services for businesses."* However, as for skills, only 45.8% of the population—aged between 16 and 74—possesses basic digital skills. We are still very far from the 80% target.

How the data is collected

To assess citizens' digital skills, DESI uses data from the EU's annual survey on ICT usage in households and among individuals, conducted by Eurostat, the European Union's statistical office. This survey is based on a sample that ensures representation according to demographic variables such as age, gender, and geographical region, but not on a practical test. It is based on a self-assessment questionnaire where respondents report the activities they have carried out online in the last three months. It is assumed that if an individual has performed certain activities, they possess the corresponding digital skills. The questionnaire [6] is not organized according to the DigComp areas, but Eurostat and national statistical offices use the responses to calculate the **Digital Skills Indicator (DSI)**, which translates practical activities into skill levels according to the DigComp framework [7].

In practice, the answers to a series of survey questions are aggregated to determine whether a person has basic skills in each of the five areas, which, as a reminder, are: 1. Information and data literacy, 2. Communication and collaboration, 3. Digital content creation, 4. Safety, and 5. Problem solving.

While not officially stated, it seems to understand that "basic digital skills" (DSI) corresponds to the **Foundation levels (DigComp A1–A2)**, and "above basic" corresponds to levels **B1–C2**. It's important to note that to be classified at the basic level, a person only needs to declare that they have performed at least one activity in most of the DigComp areas. For example, having sent an email is assumed to be proof of possessing basic skills in the "Communication and collaboration" area.

MyDigiSkills

The European Commission has made an important tool available to citizens: the **MyDigiSkills** self-assessment system (<https://mydigiskills.eu/>). This system, developed based on DigComp,

allows individuals to self-assess their skills for each of the 22 DigComp competences.

While it's an excellent **tool for self-reflection**, it suffers from the subjectivity of the responses. It's possible that novices may be convinced they know everything, while true experts, precisely because they are experts, are well aware of their own weaknesses.

METHODOLOGY

The DESI tools are certainly useful for providing a general overview of the population's digital skills, and MyDigiSkills offers individuals the possibility to self-assess.

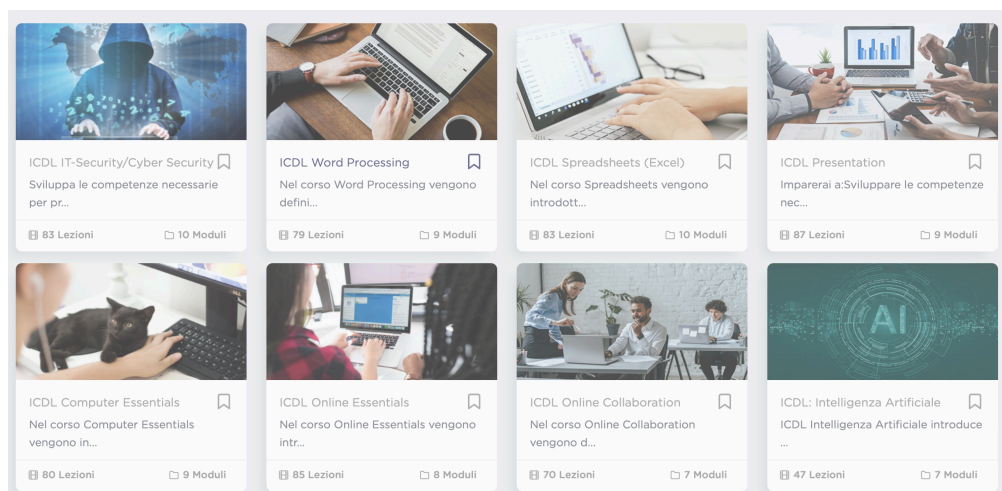
However, an organization that needs to design training programs requires more accurate measurements of the starting points and skill gaps. To design effective training, it's essential to have a clear understanding of both the destination and the starting point.

ICDL syllabuses and **DigComp** framework for digital users or **e-CF** for ICT professionals, precisely define the destination — the learning outcomes that a person should know and be able to do at the end of the training. But it's also necessary to know the starting point of an individual or a group. This is where the need for tools to evaluate and "measure" initial knowledge and skills comes from.

AICA's Competence Assessment

For this reason, AICA has developed its own digital assessment, available for individuals and organizations. It is an "objective" evaluation tool that makes it possible to verify what a person actually knows and what she/he can do. As shown in Figure 3, the assessment is centered on the ICDL modules, with one assessment for each module.

Figure 3: An assessment environment with the 7 ICDL Full Standard modules plus the AI module.



Each assessment is made up of a series of questions addressing the various topics of each syllabus. Upon completion, the assessment produces a **radar chart** highlighting areas of coverage as well as gaps in knowledge and skills. Two examples are provided in Figure 4 (Modules IT-Security and Presentation).

Figure 4: Examples of radar charts generated from the assessment results.



The image on the right shows an overview of the sCybersecurity syllabus topics in which the individual demonstrates higher or lower levels of preparedness. By clicking on the text indicated by the arrow, a more detailed report can be obtained. This feature enables learners intending to take an examination, for instance in cybersecurity, to identify areas requiring further study and practice. For course instructors, the tool allows an aggregated review of all participants' results, facilitating the identification of topics that necessitate greater instructional emphasis or the design of differentiated learning pathways.

The assessment can also be of great use to an organization that needs to define training paths for its employees. By choosing which assessments to propose them to do, the organization can identify not only strengths and weaknesses within a single module's topics but also across different modules.

Similarly, it can be used by a school or a university to test their students by class or by specialization, identifying where the most significant weaknesses are. Schools and universities have the task of contributing to the goal of 80% of people having digital skills, by ensuring that all students finish high school with an advanced DigComp level.

A high school or a technical institute should therefore be able to measure the level of incoming students to design proper digital curricula. It can also compare the results of students coming from different middle schools and provide the results back to them so that those with the worst results can review their digital curriculum.

A flexible tool

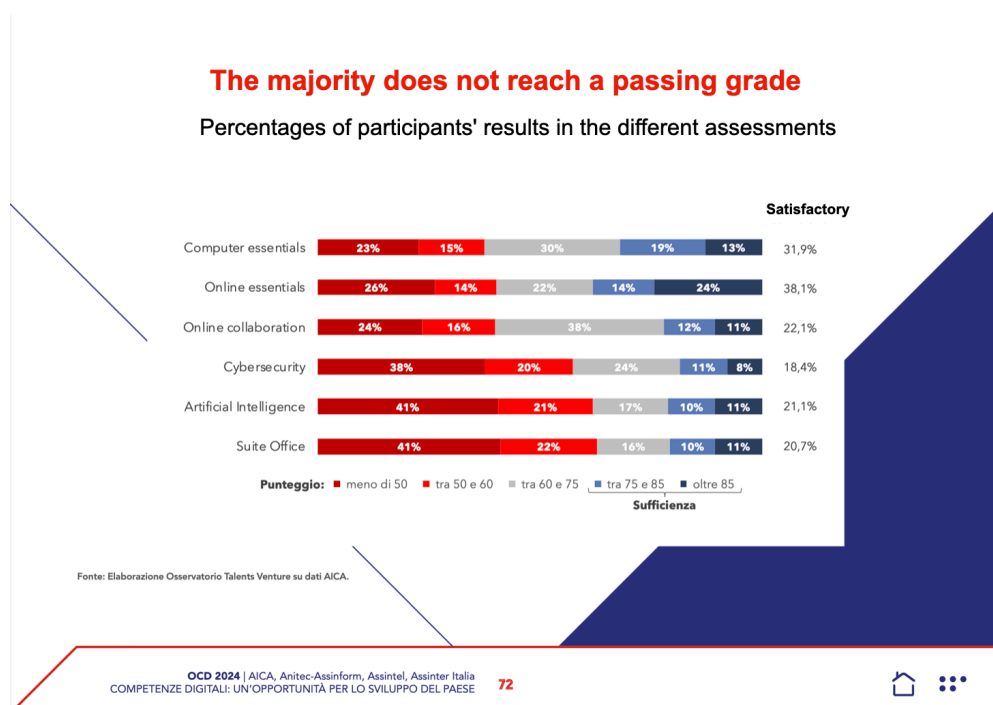
The tool is flexible and customizable. Each organization can decide which modules to offer and, if desired, the order in which to present them. The selected *assessments* can either all be immediately accessible, or one can be open with others locked to ensure they are completed in a specific sequence. Furthermore, each organization can choose whether they are only interested in the assessments or also want the MiCertifico learning materials, which consist of eBooks, Syllabi, video lessons, and self-assessment tests designed to prepare for the exams.

Currently, the following modules are available: the 7 ICDL Full Standard exams, Artificial Intelligence, two Digital Citizenship exams, and the e4Job exam. The assessment for the e-Competence Framework (ECF) will also be available soon.

Results

As mentioned, the assessment results can be useful for individuals to check their knowledge and skills on various topics, and for organizations to verify the competence gaps of their staff or, in the case of educational institutions, their students. But they can also serve to provide a more general picture.

Figure 5: A slide from the 2024 Observatory of Digital Skills



For years, AICA has been contributing to the **Observatory of Digital Skills** alongside the three other main national associations representing the sector: Anitec-Assinform, Assintel, and Assinter Italia. Since 2024, the Observatory, in addition to addressing the gap between the supply and demand of IT skills for IT professionals, has also analyzed the digital skill gaps of non-IT professionals and citizens. It did this using the results from the assessments proposed by AICA to a variety of subjects.

Figure 5 is an infographic that is part of the Observatory's 2024 report [8]. It shows the assessment results related to the modules **Computer Essentials**, **Online Essentials**, **Online Collaboration**, **Cybersecurity**, **Artificial Intelligence**, and the entire office suite (**Word Processing**, **Spreadsheets**, **Presentation**).

Results above or equal to 75% are considered sufficient, those above 85% are satisfactory, and those below 75% are considered insufficient and are divided into three ranges: 60-75% (substantially insufficient), 50-60% (severely insufficient), and below 50% (lacking skills).

CONCLUSION

The results of our assessments confirm that the level of digital competences is generally low and that there is a lot of work to be done to achieve the goal set for the Digital Decade. Access to a measurement tool capable of detecting competence gaps – such as the AICA assessment system – can support individuals in making learning choices and enable organizations to design tailored training pathways, thus facilitating the achievement of that objective.

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Digital competence frameworks in PA

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INTRODUCTION

In the public administration (PA) workforce, having a level of digital competence has become both an expectation and a requirement: with many internal and external PA processes and services now digitalised, new types of digital skills are needed. Also, as digital transformation changes the nature of jobs due to automation and Artificial Intelligence (AI), new competences are needed to design and implement public policies and digital services to take advantage of them. How do occupational digital skills frameworks in the PA context take into account this changing landscape? What are the major challenges, for example, in defining the fine line between the competence demands for typical non-IT type of digital tasks and those that border on more typical IT tasks?

Existing examples of competence framework for PA

In previous PA literature, four types of digital skills are described for civil servants: digital user skills; digital complementary skills needed to perform PA tasks transformed through digitalization, e.g. e-tax, social security, land registries; IT professional skills; and digital management and leadership skills [1]. The first three types fit well with types of digital jobs often described as ICT-enhanced jobs (e.g. digital tools like word-processing, spreadsheets), ICT-dependent jobs (e.g. hybrid digital jobs combining traditional disciplines with specialisations in digital technology) and ICT-intensive jobs, e.g. IT tasks to develop digital services and products [2,3].

Recently, occupational digital competence frameworks have emerged in PA. Spain [4] defined general digital competence in PA, focusing on non-IT types of digital tasks typical for most PA roles. Competences are adapted from DigComp and focus on digital tasks strictly outside of IT and management. On the other hand, Latvia's [5] DigComp-derived framework has a heavy focus on deepening the digital skills in public sector tasks such as "digital change planning and management, service management, efficient use of digital technologies (e.g. data analytics), ICT project management, digital infrastructure management and cybersecurity", thus focusing not only on ICT enhancing tasks, but also on transforming them (e.g. ICT-dependent jobs and IT-related tasks). Last, UNESCO, together with the Broadband Commission and ITU (henceforth UNESCO) [6], released "Artificial Intelligence and Digital Transformation Competencies for Civil Servants" unpacking the major AI and digital transformation competencies needed in the public sector (e.g. ICT-dependent jobs, IT-related tasks). The

latter two also have a strong focus on competences required in leadership, management and strategic positions.

Figure 1. Mapping previous literature on occupational digital competence in public administration (PA).

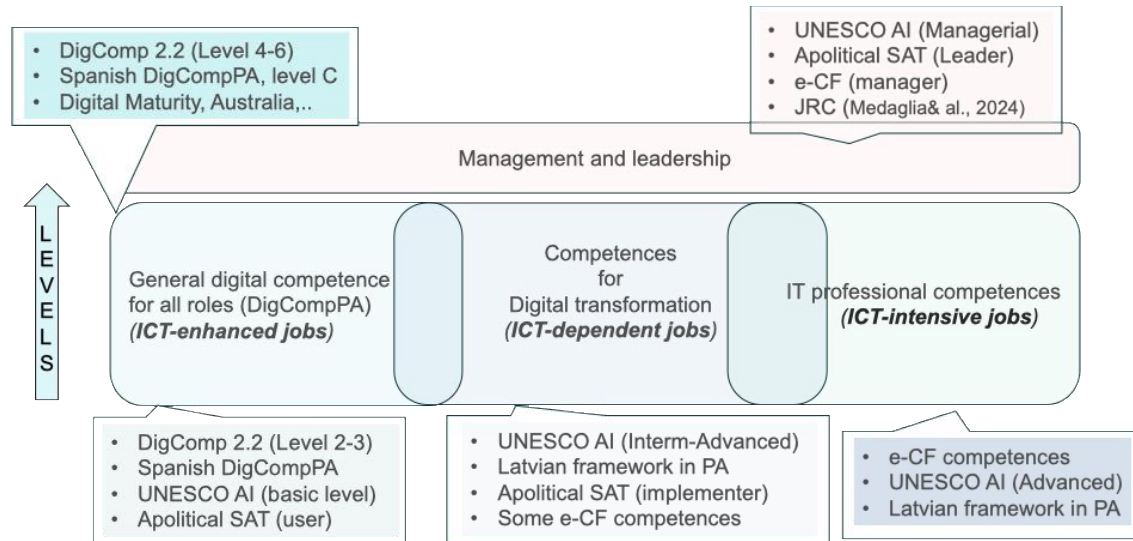


Figure 1, looking from left, shows the above-described areas: core general digital competence in PA for all roles, secondly, non-IT competences needed for digital transformation of PA and last, IT professional competences. Management, strategic and leadership skills are at the top. As described in previous literature, these areas often overlap, leaving fuzzy areas in between. For example in the area of digital transformation, multi-disciplinary teams are needed to design new digital services for PA tasks, the topic will be discussed later in Table 1. Figure 1 also shows a number of the most important references grouped under the areas, they are further detailed in [7] and forthcoming publications.

Building DigCompPA in Romania

In spring 2025, the Romanian government adopted DigCompRo for citizens [8] derived from DigComp 2.2. Next, with the focus on PA, the aim was to define an occupational core digital competence model applicable to all PA roles yet supporting digital transformation processes in the PA (DigCompPA). The current proposal calls for PA contextualised descriptors in five DigComp areas with additional ones for Digital transformation of PA (non-IT focus), and Digital leadership and governance. The work is financed from TSI by the European Commission and implemented with technical assistance from the World Bank [9].

Example: competences in Data management and interoperability

During the development process of the competence definitions and their descriptors in Romania, the challenge was to draw the line between the general digital competence for all PA roles, and those that pertain to tasks in digital transformation processes heavily relying on digital technologies, but not necessarily requiring specialised IT-domain knowledge. Today, due to the fast pace of digital development,

it is challenging to separate one from the other. This dilemma can render the usefulness of the framework in HR processes hard. Take an example in the area of data management: rudimentary competences are needed in all PA roles for naming, storing and archiving files in institutional systems, however, more advanced skills are needed to operate and work with data management systems and interoperable government architectures, e.g. those required by national/EU Interoperability frameworks. Both Spanish and Latvian competence frameworks touch upon these issues, whereas UNESCO focuses on open data. Table 1 illustrates some selected descriptors using the 3 broad areas outlined in Figure 1.

Table 2. Descriptors in “All PA positions” are from Spain, whereas the others from Latvia.

All PA positions	Digital transformation (DT)	IT team
<i>I develop a strategy for organizing, updating and storing the resources I use in my work, thus facilitating their management and retrieval</i>	<i>Contribute to the design and development of the data management infrastructure</i>	<i>Organise and oversee the establishment and development of the data management infrastructure</i>
<i>I know the National Interoperability Framework [...] to automatically exchange data between public administrations, avoiding requesting information from citizens that the administration already has.</i>	<i>Collaborate effectively with technical teams to deliver digital solutions and interoperability of services</i>	<i>Organise the architecture management of digital government solutions at industry level</i>

The top row shows an example for all PA positions “*I develop a strategy for organizing, updating and storing the resources I use in my work[...]*”. The middle column could be a task of someone working in a multidisciplinary DT team without a special IT domain knowledge but with institutional knowledge of needs for data management. The last one reaches over to more conventional IT tasks: “*Organise and oversee the establishment and development of the data management infrastructure*”. The bottom row in Table 1 also contains a second set of examples related to interoperability in the above-mentioned 3 broad areas. In these cases, the continuum of competences seems to play between typical DigComp competences and those described in e-CF, e.g. “Data management” and “Collaborating through digital technologies (interoperability)”. To come back to the challenge of creating a general competence framework applicable for all PA roles, the Romanian framework would include descriptors similar to digital transformation (DT) examples in Table 1, however, strictly scoping out specific knowledge and skills pertaining to IT professional competences. Secondly, drawing the line whether these descriptors will pertain to all roles in PA or only to specific ones in tasks related to DT will be important in the future in terms of analysing future training needs in the workforce.

CONCLUSION

In the case of Romania, it became clear that more work needs to be done in defining tasks and required competences for the digital transformation of PA, as well as their nature (IT, non-IT, something else). This would help HR processes, e.g. describing competences in job profiles, supporting career management and digital upskilling (e.g. article 4 of the AI Act¹), and better defining pay for IT

¹ <https://artificialintelligenceact.eu/article/4/>

professionals and those working on DT. Valuable resources already exist, e.g. UNESCO framework, e-CF framework [10], national examples, as well as resources such as UNESCO resources and Apolitical's AI Readiness self-assessment test².

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CDIO and EURO-INF Alignment: Professional IT Skills Development for Computer Engineers

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ABSTRACT

Driven by the need to create meaningful connections between the academic and professional spheres, the STEAM School at Universidad Europea de Madrid has developed a specific academic model focusing on the profession from a business perspective. This approach ensures that the study of various subjects contributes to a unified and practically applicable body of knowledge. Since 2012, the model has evolved through the implementation of Project-Based Learning (PBL) and, subsequently, the formal adoption of the CDIO (Conceive-Design-Implement-Operate) framework.

This paper describes how the STEAM School ecosystem aligns learning outcomes, teaching strategies, and assessment methods, fostering technical and professional IT competencies. Internal research and external assessments, such as EURO-INF accreditation, demonstrate that this methodology boosts student engagement, improves employability, and empowers students to face real-world challenges.

KEYWORDS

Project-Based Learning, Learning Outcomes, Professional Skills, Computing Engineering Education, CDIO, EURO-INF

INTRODUCTION

The increasing complexity of professional environments and the rapid evolution of technology demand that universities equip students with solid technical knowledge and the ability to apply this knowledge in real-world contexts. The STEAM School at Universidad Europea de Madrid has responded to this challenge by developing an academic model based on Project-Based Learning (PBL), closely aligned with the CDIO framework and, in the case of Computer Engineering Degree with the standards and accreditation criteria of EURO-INF quality label.

This model aims to ensure that graduates possess the competencies required by employers and society.

The objective of this paper is to present the evolution of the STEAM School ecosystem, analyse its alignment with CDIO and EURO-INF standards, and evaluate its effectiveness in fostering professional skills in IT. The paper also highlights the actual practices and structures implemented for the bachelor's degree in computer engineering, providing a detailed account of the degree's journey and its impact on student learning and employability.

BACKGROUND

Universities are expected to bridge the gap between academic preparation and industry needs, adding value to both companies and society [20]. However, a persistent misalignment remains. Graduates often encounter a significant gap between what they have learned and what is required in the workplace, particularly regarding soft skills [21, 27]. Traditional teaching methods, where professors primarily explain theory, sometimes with examples, and students focus on memorization or repetitive problem-solving, often result in superficial learning. Many students learn to pass exams rather than deeply mastering course concepts. Several drawbacks of this conventional approach have been identified:

- **Separation of domains and limited project execution:** Limited communication and feedback between academics and industry professionals is common. Although both academia and industry organize activities around processes, projects are far more prevalent in industry. In academia, projects are often confined to research, leaving students with little exposure to manage goals, resources, timelines, and risks. This limits opportunities to develop teamwork, resilience, and communication skills. This separation, for various reasons, must be addressed to fulfil the university's "third mission" of societal engagement [24].
- **Divergent environments:** Faculty are tasked with preparing students for industry, yet many lack direct industry experience. Comparative studies, e.g. those between the US and China, highlight the challenge of preparing students for unfamiliar professional contexts [16].
- **Insufficient practical experience:** While some subjects (e.g., Algebra, Calculus) may not require industry experience, others such as Software Engineering, Artificial Intelligence or Cybersecurity, or even Human Factors, benefit greatly from instructors with real-world backgrounds [8].

Project-Based Learning (PBL), rooted in the concept of Learning by Doing [4], has gained widespread adoption in secondary and higher education [19]. Institutions like Aalborg University [1, 17] have pioneered fully PBL-oriented, multidisciplinary education, emphasizing active student involvement for better outcomes [3, 26]. Since Kolb's experiential learning model [18], research and innovation in PBL have proliferated, with numerous studies confirming its positive impact on student motivation and behaviour [6, 11, 13, 23].

PBL's versatility is evident in its application across diverse areas, subjects, and curricula. Some authors link PBL to design thinking [7], while others use it to teach computational thinking as a structured approach to complex problem-solving [10]. PBL is also used for teaching agile models in Software Engineering and Design [2, 15], as well as in non-technical subjects [22]. In engineering, many schools employ PBL for both individual courses and entire curricula [12, 14]. At the STEAM School of Universidad Europea de Madrid, the adoption of PBL in 2012 was motivated by the desire to make students feel like engineers from the outset instead of just attend theoretical classes, with practical knowledge applied in isolated activities or, at best, small projects in advanced courses, projects that rarely extended beyond their specific subject.

The primary goal of PBL is to provide students with practical learning opportunities in a supportive environment, facilitating the transfer of knowledge from academia to the workplace [11, 15, 24]. However, some authors note that this transfer is not always seamless [6]. To address these challenges, describes the gradual introduction of innovative methodologies from the earliest courses as a key factor for success.

With this vision, the STEAM School embarked in 2012 on the journey to become a project-based learning institution, aiming to build an ecosystem encompassing all levels of experiential learning. The foundation is hands-on learning in every subject. The next step is the integration of projects every year of the degree from first course. This is followed by the design of integrative projects spanning multiple subjects or courses. Finally, the ecosystem includes informal project-based learning through the empowerment of student clubs.

MAIN FOCUS OF THE ARTICLE

Over the past decade, the STEAM School at Universidad Europea de Madrid has advanced through a series of phased initiatives, all aimed at maximizing the impact of Project-Based Learning (PBL). These efforts have focused on four main pillars:

1. **Industry Collaboration:** This pillar involves strengthening ties with the business sector. PBL is most effective when companies are actively involved [5], whether in defining challenges, monitoring progress, or evaluating outcomes. Drawing inspiration from the Triple Helix Model [28], the school has established various forms of collaboration, including Strategic Allies—companies that participate in the design, development, and evaluation of projects—and Industrial Partners who contribute to the school's facilities and academic activities.
2. **Faculty Development:** Faculty training in PBL methodology has been a cornerstone, as highlighted by other authors [14]. The school has implemented specific training programs, developed classroom tools such as project definition templates and evaluation rubrics, and organized regular meetings for sharing best practices. Additionally, the faculty has been

intentionally balanced between those with academic backgrounds and those with significant industry experience, ensuring that students benefit from exposure to current technologies and real-world practices across disciplines.

3. **Transformation of Facilities:** To support project work [12], the school has reimagined its physical spaces. Laboratories and facilities are no longer reserved for research groups but are open to undergraduate students, requiring not only physical changes but also shifts in culture and resource management. Notably, a collaborative workspace of over 400 square meters was created and an advanced computing centre with more than 700 cores, enabling both students and faculty to participate in projects that mirror those found in industry.
4. **External Recognition:** The last pillar is aimed at the search for international bodies to certify the quality of students' learning. Accreditations, such as, NAAB (National Architectural Accrediting Board in USA) or RIBA (Royal Institute of British Architects in UK) [27] for the Architecture Degree, and EURO-INF [29] for Computing engineering are good examples.

These four pillars have been the foundation of the STEAM School's evolution over the past thirteen years, as detailed in the following sections.

Thirteen Years of Project-Based Learning: Phases and Outcomes

The 2024/2025 academic year marked the thirteenth anniversary of PBL implementation across all STEAM School degrees, a transformation that led to the school being known as the Project Based School (PBS). The evolution of PBS can be divided into three main phases:

1. **Projects as Learning Activities:** Initially, projects were integrated as learning activities spanning several subjects within the same academic year (horizontal integration) [24]. The aims were to enhance motivation and sense of belonging among students and faculty, facilitate deeper learning of engineering skills, develop generic skills (teamwork, communication, independent learning, planning), and connect classroom learning with professional practice.

Three factors enabled this initiative: (i) a top-down decision by school management, ensuring commitment from teachers and program leaders; (ii) a dedicated teacher training program; and (iii) an integrated project template to align learning activities. The results were promising, both teachers and students reported increased motivation, students valued project integration for deepening their knowledge, and there was a perceived improvement in generic skills. However, two main drawbacks became apparent: the success of PBS depended heavily on teacher engagement, and the adoption of PBL varied across degrees. To address this, special project subjects were introduced into curricula,

ensuring that all students developed projects applying content from other subjects concurrently or sequentially.

2. **Projects as Subjects:** In 2015, the STEAM School elevated PBL by updating all engineering degrees to include dedicated project subjects. In the case of Computer Engineering, first year students engaged in an “Engineering Project” to apply foundational competencies (math, physics, programming, business). In the second year, “Computer Science Project” courses focused on programming, software engineering, databases, and microcontrollers, split across two semesters. The third year featured a “Computation Project” emphasizing advanced databases, artificial intelligence, and user interfaces. No project courses were included in the fourth year, allowing students to focus on their mandatory capstone project.

Quantitative analyses from the 2021-22 academic year [3] revealed several key findings. Project-focused courses provided experiential learning opportunities, helping students consolidate theoretical knowledge and develop skills like teamwork and problem-solving. Student motivation improved, leading to a significant reduction in dropout rates and gains in teamwork, project management, and decision-making were perceived, as well as a deeper understanding of technical competencies, reflected in improved pass rates in traditional subjects.

3. **PBL 2.0: Methodological Refinement:** In 2022/2023, the school sought to deepen its understanding of classroom dynamics by pursuing three objectives: establishing a uniform vocabulary for PBL among all teachers, disseminating this shared vocabulary, and providing teachers with practical methodological tools. The result was the creation of a “PBL 2.0 agenda,” a living document composed of collectible cards that explain the rationale for PBL, define its implementation, and offer guidelines for project design, assessment, feedback, and rubric construction.

The STEAM School as a Learning Organization

To foster continuous and intentional growth, the school developed a PBL ecosystem characterized by a strong learning culture, a shared vision, and a psychologically safe environment for personal and professional development [9, 10]. Key entities within the ecosystem include:

- Three Think Tanks: The Industry Advisory Board (22 professionals from diverse sectors), the Academic Think Tank (10 senior faculty members), and the Alumni Advisory Board (selected graduates). These groups provide prospective analysis, internal discussion, and alumni engagement.

- **Faculty Gatherings and School awards:** At the end of each academic year, faculty present and benchmark project outcomes, sharing best practices and leveraging collective learning. Each September, best projects in each category are showcased and judged by company representatives, who select the winners. This event strengthens ties with industry and motivates students.
- **European Workshop on Project-Based Learning:** Held annually in November, this event brings together European universities to share best practices and challenges, promoting continuous improvement.
- **Strategic Allies, Industrial Partners and Academic Model Directorate:** The school maintains strong relationships with industry, involving companies in program design, academic activities, facility planning, and methodological improvement who are foster by an office, within the Provost for Faculty and Research, which sets the overall guidelines for experiential learning at the university.

External validation of performance: CDIO and EURO-INF

An external evaluation was held in 2021/2022. This assessment included a report from a consulting company specializing in PBL in education, and a visiting professor with expertise in neuroscience and active methodologies joining the faculty for a month.

In academic year 2022-23, the School began the process to apply for admission within the CDIO initiative. CDIO focuses on the entire life cycle of engineering projects to train engineers so that they can apply knowledge in real-life situations. The combination of PBL with the Conceive–Design–Implement–Operate (CDIO) approach has been explored in the academic literature, highlighting that both methodologies share fundamental values and can partially overlap as strategies for educational reform [5]

In 2024, the Bachelor's Degree in Computer Engineering also submitted its application to be evaluated against the standards of the EQANIE EURO-INF seal [29]. To achieve this objective, a dedicated working group was established, comprising the quality assurance managers (RC), the degree coordinator (CT), and the deputy director of the STEAM School (SD). This team initiated the process of drafting the self-assessment report, which unfolded through the following distinct phases:

- **Needs Identification:** Under the guidance of the quality managers (RC), the required actions and their respective responsibilities were defined and scheduled over time. A shared digital workspace was created to host all documentation related to the process (Link), and regular follow-up meetings were instituted.

- **Development of the Subjects–Sub-Outcome Mapping Table:** The degree coordinator (CT) and the deputy director (SD) produced an initial mapping table linking curriculum subjects to EURO-INF sub-outcomes. This table was distributed to faculty members responsible for each subject, allowing them to provide feedback and suggest modifications.
- **Completion of the Mapping Table:** In this phase, each faculty member populated the table with information regarding the content, learning activities, and assessment methods relevant to the sub-outcomes addressed by their respective subjects.
- **Review and Simplification of the Table:** The CT, SD, and RC collaboratively reviewed the table to identify inconsistencies or gaps and to prioritize subjects that most effectively contribute to each EURO-INF sub-outcome. It was agreed to limit the analysis to a maximum of four subjects per sub-outcome.
- **Drafting the Self-Assessment Report and Compiling Evidence:** Concurrently, the self-assessment report was developed and subjected to multiple rounds of revision. Supporting evidence was systematically organized within the shared workspace.

Results and Impact

Over the first twelve years of PBL implementation, the STEAM School generated an average of 30 projects per year, involving 12 degrees and 65 teachers. The data show an increase in the number of projects year after year, except for the pandemic years, going from 20 project in 2012 to a maximum of 50 projects. Since 2016, Universidad Europea de Madrid has conducted student satisfaction surveys to assess the impact of teacher training on the learning model. Last year, 84.2% of students reported being “satisfied” or “very satisfied” with the model, with comments such as: “In a general framework, the university establishes the best teaching and evaluation methodologies in each of the subjects, so that the student achieves extensive knowledge of everything.”

Specifically, in the field of computer science, very good results have been achieved in terms of key academic performance indicators (KPIs) over the past 10 years. The number of no-shows to the exams has dropped from 25% to less than 10%. The pass rate has increased from 65% to over 80%, and the success rate has increased by more than 20 percentage points. Results of the governmental reaccreditation process were outstanding in six out of seven criteria, including those related to Learning Outcomes and Performance and Satisfaction Indicators and identifying as strengths the solidity of the curriculum with a good mathematical and technological base combined with specific competence development subjects very much aligned with the EURO-INF sub-results. In fact, recently, the Bachelor's Degree in Computer Engineering, one of the degrees with the highest volume of students at the School, has obtained the EURO-INF recognition [29]. A further demonstration of the alignment of the skills that students acquire with those needed by the world of work.

It is very important to insist on the influence that the PBL methodology has on the way in which most of the sub-results of EURO-INF are achieved, since the integrative projects are the activities in which students apply and consolidate all the knowledge acquired in the rest of the subjects. That is why, in the correlation table between sub-results and subjects, project subjects appear quite frequently, since they are the best evidence that certain learning outcomes are worked on and evaluated. In the same way, it is these subjects that contribute to the most collaborative work.

Alumni have reported high levels of acceptance and integration into the workforce, attributing their success to the practical, business-oriented scenarios experienced during their studies. Companies have also expressed satisfaction with the PBL model, both as judges in the School Awards—where they can assess project quality and rigor—and as employers, where graduates demonstrate strong technical and soft skills such as teamwork, responsibility, autonomy, and communication. As one company jury member stated: “I take this opportunity to thank you for your involvement in these awards which, from my point of view, are very interesting for all parties, and above all and especially for the students. Congratulations on the work and the result.”

CONCLUSION AND ACKNOWLEDGMENT

The STEAM School at Universidad Europea de Madrid has implemented a project-based learning ecosystem aligned with CDIO standards, resulting in improved learning outcomes and the development of professional IT skills. The constructive alignment of curriculum, active engagement with industry, and continuous evaluation pursue that graduates are well-prepared for the demands of the modern workforce.

Feedback consistently received over the years from many stakeholders, as well as from alumni after having been working for several years, allow us to infer that project-based learning makes students engage more, learn better, and is much more effective for them to develop the set of soft skills required by companies. When project-based learning is combined with strong industry collaboration, students gain both the knowledge required for graduation and the opportunity to develop important soft skills. By working on projects and facing real-world challenges, students gradually build abilities such as teamwork, resilience, communication, and proactivity. Incorporating project-based learning with industry involvement can contribute to a more comprehensive educational experience.

The authors acknowledge the contributions of students, faculty, coordinators, industry partners, and the CDIO network in supporting this transformation.

APPENDIX. SUMMARY OF MAPPING TABLE

EURO-INF LEARNING OUTCOMES	Fundamentals of Computer Science					Analysis					Design and Implementation					Legal, Social, Ethical, and Environmental				Practice of Computer Science					Other Competencies and Professional Skills				
	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5
Programming Fundamentals									X							X													
Object-Oriented Programming							X		X							X													
Personal and Professional Effectiveness																	X								X		X		
Mathematical Analysis	X							X																					
Computer Structure	X										X																		
Engineering Project							X			X											X							X	
Algebra	X																												
Computer Science Basics	X	X																											
Network Fundamentals											X									X									
Physics Fundamentals for Engineering																						X							
Database Fundamentals						X	X																X						
Relational Impact and Influence																	X									X		X	
Circuit Analysis						X	X																						
Computer Science Project I				X						X		X		X															
Computer Science Project II				X						X		X										X							
Statistics and Optimization	X																							X		X			
Programming with Linear Structures									X							X													
Introduction to Software Engineering												X									X								
Advanced Programming Techniques						X	X		X																				
User Interfaces				X										X						X									
Web and App Development				X								X		X		X													
Artificial Intelligence				X			X									X								X					
Computer Networks											X								X										
Operating Systems		X	X																										
Intelligent Systems and Knowledge Repres.				X				X																					
Computing Project I												X												X			X		X
Computing Project II												X	X																X
Entrepreneurial Leadership																	X					X	X					X	
Business and Legislation																	X	X				X							
Software Engineering						X				X							X			X									
Company Internships																X									X		X		
Extended Company Internships																									X				
Big Data			X										X											X					
Systems Administration		X																	X		X								
Compilers and Formal Languages			X																										X
Digital Transformation Management																		X	X										
Computer Security																		X	X										
Final Degree Project																							X		X	X	X		

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The use of the e-CF in skills related EU-projects

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ABSTRACT

This study investigates the application of the European e-Competence Framework (e-CF) in EU-funded ICT skills development projects, particularly under the Erasmus+ and Digital Europe programmes. Through a multi-case analysis of ten projects, it explores how the e-CF and its associated frameworks are used in project phases including needs analysis, strategy formulation, and educational design. While the e-CF is recognised as European standard for ICT professionalism, its practical use in current projects is limited and inconsistent. Only a few projects demonstrate meaningful integration of the e-CF, often driven by prior consortium familiarity with the framework. The paper highlights challenges such as competing policy focus on other EU instruments like DigComp and ESCO. Recommendations include deeper integration of the e-CF in all project phases and better use of its value through expert involvement.

Keywords: e-CF, e-competence framework, Blueprint projects, Erasmus+, DIGITAL, European Sector Skills Alliances

INTRODUCTION

The European e-Competence Framework ('e-CF')[1] is a European standard developed to define the competences, skills, and knowledge required by ICT professionals across Europe. It offers a common language for discussing ICT-related qualifications, ensuring clarity and comparability across different sectors and countries. Given its purpose, the e-CF is expected to play a central role in EU-funded projects focused on upskilling and professional development in ICT. This paper introduces a multi-case study [2] that explores the actual use of the e-CF within such projects and how it is applied when used.

The e-CF eco-system

The e-CF (EN16234)[1] is developed and maintained by CEN Technical Committee 428, which oversees standardisation efforts related to ICT professionalism and digital competence. The framework defines 41 core competences that are essential to ICT professionals, such as Data Science and Analytics and Information Security Management. These competences are categorised and described across varying proficiency levels to assess skills in a neutral and vendor-independent way. This allows both professionals and organisations to evaluate existing capabilities and identify development areas. The e-CF is not a standalone tool but part of a broader ecosystem of interconnected frameworks that provide additional depth and guidance for its practical implementation.

The ICT Professional Role Profiles (CWA16458) [3] framework defines 7 role families with 30 role profiles, such as Developer and Technical Specialist. Each profile incorporates a tailored selection of the 41 e-CF competences, helping professionals and organisations align skills with job roles more effectively. Each role can also be further specified in more specific profiles relating to a certain technology or a specific context.

The ICT Foundational Body of Knowledge (ICT BoK, EN17748) [4] supports the competence descriptions in the e-CF by detailing 42 knowledge units that form the foundation of ICT expertise. Each unit is mapped to relevant e-CF competences and role profiles, which provides insight in the fundamental knowledge expected of ICT professionals.

The ICT Curriculum Guidelines (TS17699)[5] provide practical advice to education providers on how to design or revise ICT curricula in alignment with the e-CF. It introduces the ‘educational profile’, a tool that helps translate professional requirements, such as specific competences or roles, into educational outcomes. This enables universities, training providers, and vocational institutions to use a shared European language when designing ICT learning programmes, ensuring better alignment with the needs of the labour market.

The cases

There is a range of EU-funded projects that are focused on skills development, and especially on the skills that ICT professionals need, many of which receive support under the Erasmus+ and Digital Europe programmes. Erasmus+ has a yearly returning call for European Sector Skills Alliances, which implement the Blueprint for Sectoral Cooperation on Skills [6]. The purpose of the Blueprint is to gather skills intelligence, design targeted educational and training programmes and develop long-term strategies to address skills shortages and unemployment while using EU tools. These tools include for example, EQF, ESCO, Europass and, for ICT-related sectors, the e-

CF [7]. Besides these Blueprint projects, the Digital Europe Programme (DIGITAL) is focused on bringing digital technology to businesses, citizens and public administrations. Projects under this programme may also include skills needs analyses and the design of learning opportunities, so they can be compared to the Blueprint projects in terms of their use of the e-CF. Current ICT-related projects under these programmes are analysed to gain an understanding of whether the e-CF is used and if so, how.

Table 1. List of projects

Name	Topic	Programme	Period
CHAISE	Blockchain	ERASMUS+ (Blueprint)	2020-2024
REWIRE	Cybersecurity	ERASMUS+ (Blueprint)	2020-2024
ESSA	Software Services	ERASMUS+ (Blueprint)	2020-2024
ARISA	Artificial Intelligence	ERASMUS+ (Blueprint)	2022-2026
Digital4Sustainability	Digital for Sustainability	ERASMUS+ (Blueprint)	2024-2028
SMARCO	Smart Communities	ERASMUS+ (Blueprint)	2025-2029
SMACITE	Smart Cities	DIGITAL	2022-2025
Digital4Business	Digital for Business	DIGITAL	2022-2026
Digital4Security	Digital for Security	DIGITAL	2023-2027
CyberHubs	Cybersecurity Skills Hubs	ERASMUS+	2024-2026

Objectives

The analysis in this paper of how the e-CF is used in skills related EU-projects, provides valuable insights into how the use of e-CF can be improved. The objectives of this paper are therefore:

- To provide an overview of the use of the e-CF in skills related EU-projects,
- To formulate recommendations to improve the use of e-CF in these kinds of projects.

THE E-CF AS COMMON LANGUAGE

There are several stages in skills related projects where the e-CF can be used. A logical starting point is including it in the proposal and then in the Grant Agreement and the EU Funding Portal when a project is granted. Most skills related projects start with a skills needs analysis and the definition of a skills strategy, in both of which the e-CF can play an important role. This is followed by the design of solutions, mainly learning programmes to up- and reskill professionals in which the e-CF can certainly be important. In the pilot phase, the role of the e-CF may be less relevant. The question is whether projects indeed use the e-CF in those phases and if so, how. Each project will be analysed according to its use of e-CF in these stages.

Awareness of the e-CF in projects

The first important aspect is whether there is an awareness of the e-CF in a consortium that is running a project. This of course, starts by using it in the Grant Proposal, but also later on in the project by mentioning it on the website or by making it part of the conversations within the consortium.

Official documents

Several projects [ESSA, ARISA, Dig4Sust, CyberHubs] mention the e-CF and explain how they intend to apply the framework in their formal proposals.

The e-CF is mentioned frequently in the formal 'Project description' of ESSA. It describes that the framework, together with the ICT Professional Role Profiles, are the logical instruments to use throughout the different phases of the project, from "identifying the occupational profiles for software roles to define their skills needs and the required proficiency levels" to "designing the strategy and curriculum for selected e-CF competences and software services related job roles derived from European ICT Professional Role Profiles". Several partners participating in this project were well aware of e-CF and related reports. They were involved in earlier projects related to e-CF (e.g., e-CF Alliance project, 2015-'18), as well as in CEN TC428 standardisation projects and activities.

The same applies to the Dig4Sust project, which also involves various partners who are already familiar with the e-CF. According to the project's technical description, here too, vocational training and higher education programmes for selected key jobs in the twin green and digital transition, as defined by current labour market demand, will be aligned with the e-CF, among other.

In the Grant Agreement of the CyberHubs project, the e-CF is mentioned in the section that explains the methodological approach, as one of the EU instruments and tools related to skills, occupations and roles. Again, several partners in this project are already familiar with the e-CF. The authors did not have insight in these formal documents of the other projects. However no reference to the e-CF was found in the Factsheet descriptions of these projects on the EU Funding & Tenders Portal.

Websites and other communications

The common starting point for information about a project, is the project website. Whether the e-CF is mentioned on the project website provides an initial indication of the importance and use of e-CF in the project. Five projects mention the e-CF on their webpage [ARISA, CHAISE, CyberHubs, ESSA, SMACITE]. Three of them do so quite prominently ([Introduction](#) [ESSA], [Learning provider page](#) [ARISA], [Training program page](#) [SMACITE]), while two do so in a less

visible place [[News item](#) [CHAISE], [Resources](#) [CyberHubs]]. One of these two projects [CHAISE] mentions the e-CF in a news item on its website, stating it will use the e-CF, but unlike this statement, does not actually use the e-CF in the project. The other project [CyberHubs] only applies the e-CF indirectly (via another framework, the European Cybersecurity Skills Framework (ECSF)), but a reference is made to the e-CF. However, there are also two projects [Dig4Sust, REWIRE] that use the e-CF in one or more of their deliverables, but do not mention the e-CF on their website or in other communications.

E-CF guiding skills needs analyses and strategy development

Every Blueprint project and also most other skills related projects, carry out a skills needs analysis to determine the market need for roles and competences. In Blueprint projects, the results of the skills needs analysis are used as input to formulate a skills strategy for the specific field. Five projects mention and/or use the e-CF and/or related documents in their needs analysis report [ARISA, D4Sust, ESSA, REWIRE, SMACITE]. One project [SMARCO] has started only recently, so most of its deliverables are not yet available.

ARISA refers to the e-CF, the Curriculum Guidelines and the BoK in the glossary and references list of their Needs Analysis, but it is unclear how these reports are applied in the research. In the related [AI Skills Strategy report](#), the e-CF and related ICT professional role profiles are mentioned as possible “European frameworks to consider [...], in which AI roles could be introduced as generation 3 roles and AI skills can be placed in already existing e-CF competences”. However they decide not to at this moment: “Given the young nature of the field and the rapid and dynamic developments of both roles and skills in this field, we do not consider it prudent to engage in this alignment until several iterations of the Needs Analysis and Strategy have taken place”.

In REWIRE, the e-CF and especially the design principles of the ICT Professional Role Profiles were used to construct a cybersecurity framework with. The project explicitly refers to the e-CF and briefly explains it in their Needs Analysis among more specific Cybersecurity frameworks. This project builds on earlier results from other cybersecurity projects, among which the ECHO project. In that project, a Cyberskills Framework was developed, the precursor to ENISA’s [European Cybersecurity Skills Framework \(ECSF\)](#). After an extensive elaboration on the e-CF, [ECHO’s Cyberskills Framework report](#) states clearly that “the most relevant component of the e-Competence Framework and the derivative standard is the structure of the professional profile where the tasks are mapped to the competences and proficiency levels. This approach is adopted in the ECHO Cyberskills Framework also. It is appropriate for better defining the proficiency levels according to the responsibilities and accountability of the relevant profile and its tasks”. In the

work done in the REWIRE project, their [Methodology report](#) explains that ECHO's framework is used because design principles of the Cybersecurity Framework "should fit to European landscape of standardization and legislation. The e-CF was selected as a reference point. Upcoming Cybersecurity Skills Framework will follow the construction approach of the above-mentioned Norm". There are other projects (outside the scope of this research) that apply the ICT Professional role profiles template to describe other profiles, not necessarily ICT related. One example is the SPIRE-SAIS project on Sustainable Process Industry, that not only uses the template but also provides a family tree, similar to the one in the ICT professional role profiles report in their [Company Skills Requirements report](#).

In the Dig4Sust project, an initial desk research was conducted to determine which roles are already defined as important and should be studied further. Then in the [Needs Analysis](#), "the role profiles were defined in more detail [...]. The starting point for formulating role profiles was the e-CF, the CEN ICT professional role profiles, and relevant occupations defined in ESCO". The [Digital Sustainability Skills Strategy](#), building on this research, uses the e-CF and the ICT professional role profiles as one of the elements of its strategic scope to define skills and roles. The Strategy also advises to use educational profiles (as presented in the Guidelines for ICT Professional Curricula (TS 17699) [4] to translate market demands into learning programmes.

The ESSA project dedicates a full paragraph of multiple pages in their Needs Analysis including several figures explaining the e-CF and the ICT professional role profiles and their relevance to the project. In their [Skills Needs research](#), five roles are selected that require software skills as an essential part of their profile. Also relevant e-competences from the e-CF are selected to guide the analysis. Additionally, the project published a separate [Software Professional Role Profiles booklet](#) that presents the adjusted role profiles for software professionals. These roles are also core to ESSA's [Software Skills Strategy](#) and also this document explicitly addresses the relevance of e-CF and the ICT professional roles. Besides, it also highlights the fact that using relevant European standards and classifications is a key purpose of European alliances for sectoral cooperation on skills, stating that: "This enables cooperation by creating a common language around roles, competences, and skills, that facilitates the development of curricula and recognisable learning programmes with broad support. Various standards and classifications are relevant in this regard, notably e-CF, European ICT Professionals Role Profiles, ESG and EQAVET, and ESCO".

The SMACITE project uses e-CF (and ESCO) in their desk research to identify a [Competences Map](#) with emerging job profiles, stating: "Linking the profiles of SMACITE to the standard EN16234:2019, also known as e-CF, is something stated in the proposal of the project and it is

well connected to the reality of job profiles in the EU”. The approach followed with e-CF was “the mapping of the resulting set of functions *[of profiles]* ... to the most linked e-competences and proficiency levels in the standard. The recently started SMARCO project mentions the e-CF several times in its [Competence Matrix](#) for short term training report, stating it aligns with frameworks such as e-CF, but it is not directly clear how this alignment has been achieved.

The role of the e-CF in educational design

The ICT curriculum guidelines technical specification (TS 17699) describes the role that the e-CF can play in curricula design. The concept of educational profiles is used to translate market needs into educational terms. E-CF competences are translated into learning outcomes in that process. The guidelines as part of the e-CF eco-system also provide further guidance to design curricula that are aligned with the starting points of the e-CF [4].

Educational profiles are explicitly used in four projects [ARISA, ESSA, D4Sust, SMACITE]. In two of those projects [ESSA, SMACITE] these educational profiles were used to design curricula. In ARISA, the profiles were not used directly and a scraping method was used as a starting point for defining learning units and curricula. In the Dig4Sust project it is still unclear how the educational profiles will be used in the design of the curricula, but so far in this project the curricula were “assembled” as they call it, before the educational profiles were developed.

Alternatively, the SMACITE project provides a [Diagnostic Tool](#) to assess training needs, using a scale for knowledge and skills related to e-CF, EQF (European Qualification Framework), and ESCO (European Skills, Competences, Qualifications and Occupations). ESSA produced a [certification framework](#) based on e-CF. Additionally, any education and training provider that fulfils a certain set of criteria, like using the ESSA educational profiles, can obtain the ESSA Quality label as well. The ARISA project took the initiative to start the development of a [CEN Workshop Agreement \(CWA\)](#). Building on the project results, this document focuses on AI roles and educational profiles, and is designed as a generation 3 role profiles set, fully aligned with the e-CF [8].

CONCLUSION

The main finding of this study is that the e-CF is used only sparsely in EU funded skills projects related to the field of ICT, despite the fact that it is the European standard related to ICT skills. This is unfortunate, given the potential of the e-CF as a common language for discussing ICT professionals and the competences they need.

Table 2. Application of e-CF in projects

Name	Formal	Website	Needs analysis	Strategy	Education design	Other
CHAISE	?	Less visible	NO	NO	NO	NO
REWIRE	?	NO	Applied	Applied	NO	NO
ESSA	Explained	Prominent	Applied	Applied	Applied	Quality label, Cert. framew.
ARISA	Explained	Prominent	Mentioned	Mentioned	Slightly applied	CWA
Digital4Sust.	Explained	NO	Applied	Applied	Applied	NO
SMARCO	?	NO	?	?	?	?
SMACITE	?	Prominent	Applied	?	Applied	Assessment
Digital4Bus.	?	NO	NO	NO	NO	NO
Digital4Sec.	?	NO	NO	NO	NO	NO
CyberHubs	Mentioned	Less visible	Indirectly	Indirectly	Indirectly	NO

Current usage appears to be even lower than before. It seems that projects completed longer ago made more use of the e-CF. The reason behind this apparent trend is not entirely clear and cannot be attributed to a single cause. One important cause may be the EU's focus on Digcomp, which is about literacy for citizens but is trying to extend its reach to digital professionals. This distracts attention from the fact that a standard for ICT professionals already exists, namely the e-CF. EU projects also pay a lot of attention on ESCO, the classification of European Skills, Competences, Qualifications and Occupations. Both DigComp and ESCO have been heavily promoted by the European Commission. This overview of all types of professions and skills may be useful, but it is not structured in such a way as to provide insight into the ICT field and does not take the e-CF standard into account, for example by not including the e-CF competences. This focus on ESCO may also be a reason why the use of the e-CF in projects is considered less urgent.

We also observe that when the e-CF role profiles are specified for a specific context, the so-called 'generation 3' profiles, they are used, especially when they are promoted. The case of the ECSF is a best practice of this way of using the e-CF. Another observation is that once there is some awareness of the e-CF and related documents within a project, it is very likely that it is applied in the project.

Recommendations for current and future projects are:

- Not only mention the e-CF, but also use it explicitly in the needs analysis, skills strategy and educational design, and communicate this clearly.

- Where available, use Generation 3 role profiles (cybersecurity, AI) as a reference point and consider developing Generation 3 profiles in the context of the project when these are not available.
- If expertise on the e-CF is not yet available in the consortium, engage experts to advise on the potential added value of using the e-CF.

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Evolving demand for ICT competences in Europe: insights from online job advertisements (2020–2025)

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ABSTRACT

This article examines labour market demand for ICT competences in Europe between 2020–2025 using CEDEFOP Skills-OVATE job ad data. Demand rises steadily, with strong acceleration after 2021 driven by digitalisation. Software developers and systems analysts dominate ads, but ICT managers, administrators, and support technicians also show notable demand, pointing to a layered competence structure vital to Europe’s digital economy. The UK, Germany, and France generate nearly 60% of postings, while national patterns reflect diverse transformation strategies. Transversal competences differ: managers prioritise leadership, developers stress adaptability and teamwork, network staff consultancy, and technicians service orientation. Results highlight ICT professionalism as a mix of technical and soft skills, guiding education and training policies to meet Europe’s Digital Decade goals

Keywords: ICT Specialists, Online Job Advertisements, Digital Skills, IT Professionalism, Labour Market, Europe

INTRODUCTION

The rapid growth of the digital economy has sharply increased demand for ICT professionals across Europe. As organizations advance digital transformation, the availability of skilled workers is a key factor for competitiveness and innovation [1]. Labour market intelligence is needed to track these dynamics and guide training and policy. Online job advertisements (OJAs) are especially useful, offering near real-time insights into occupational demand, skills, and regional variation [2][3]. Unlike traditional statistics, OJAs capture short-term changes and role-specific

trends.

This article analyses ICT competence demand in Europe (2020–2025) across three dimensions: overall trends, role-specific growth, and cross-country variation. The aim is to clarify evolving ICT competences and support strategies for workforce development and professionalism.

BACKGROUND

ICT competences are central to modern labour markets and are formally defined within the European Skills, Competences, Qualifications and Occupations (ESCO) framework. ICT competences are formally defined within ESCO [1]. In recent years, OJAs have become a central instrument for labour market intelligence, providing near real-time data on skills demand. The report [4] highlights how this approach strengthens skills intelligence by identifying digital competences across a wide range of occupations, not limited to ICT profiles. Similarly, Cedefop's Skills-OVATE tool, based on millions of job postings, provides real-time insights into emerging digital and green skills [5]. Earlier policy briefs, such as "Going digital means skilling for digital (2023)", stress that while ICT specialist demand remains high, digital competences are now indispensable across many non-ICT roles, underscoring the rise of digital literacy as a transversal skill [2].

The OECD has also contributed significantly to this field [3]. Complementing this, the OECD Skills for Jobs Database uses OJA-derived mappings to reveal that digital competences increasingly appear in occupational groups beyond ICT specialists, including business services, manufacturing, and health [6].

Existing studies confirm the importance of digital competences but mostly focus on general demand or single countries. Few analyses systematically connect role-specific growth with cross-country variations. This article addresses this gap by linking demand patterns for ICT roles with geographical differences, offering new evidence for understanding how digital competences evolve across Europe.

METHODOLOGY

Data source and scope. The study used ICT-related OJAs from the CEDEFOP Skills-OVATE platform, covering 32 European countries between 2020 and early 2025. The focus was "ICT specialist" roles under ISCO-08, including managers, developers, analysts, network professionals, and support technicians. Data were aggregated annually.

Analysis. A descriptive approach was applied using Excel. Annual totals were calculated to show overall demand trends. Roles were grouped by occupation to identify which jobs were most in

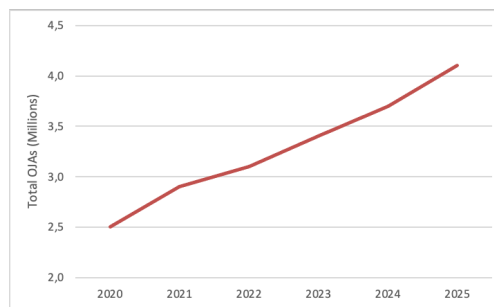
demand. Country-level totals were compared to reveal geographical differences. Finally, a cross-tabulation of the top roles in the five largest markets allowed direct comparison across countries.

FINDINGS

Yearly trend analysis

Paragraph Figure 1 illustrates the evolution of ICT job advertisements between 2020 and 2025. The data reveal a steady increase in demand, rising from approximately 2.5 million postings in 2020 to more than 4.1 million in 2025. A notable acceleration occurs after 2021, coinciding with post-pandemic recovery and the broader push for digitalization across European economies.

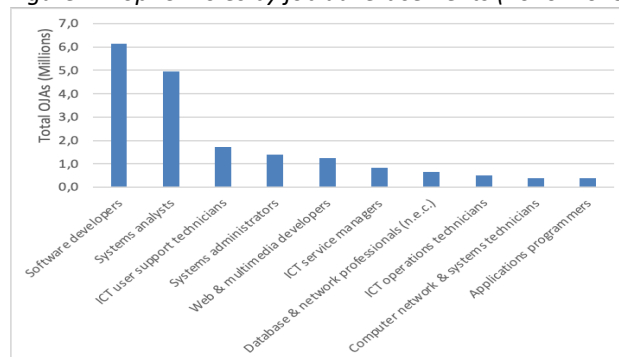
Figure 1. ICT Job Advertisement Growth (2020–2025)



Role-specific demand analysis

Figure 2 presents the distribution of postings by role. Software developers (6.1 million postings) and systems analysts (4.9 million) dominate the market, together accounting for nearly 60% of all ICT OJAs. Beyond development roles, significant demand is observed for ICT user support technicians (1.7 million), systems administrators (1.4 million), and web and multimedia developers (1.2 million). These findings indicate that while advanced programming and analytical competences remain core, organisations also require strong operational and managerial capabilities to support digital transformation [7] [8] [9].

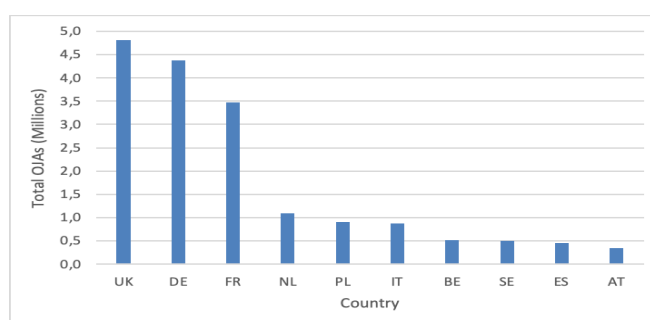
Figure 2. Top ICT roles by job advertisements (2020–2025)



Country-level comparison

Figure 3 compares demand across the ten countries with the highest volume of ICT postings. The United Kingdom leads with 4.8 million postings, followed by Germany (4.4 million) and France (3.5 million). These three countries together represent nearly 60% of ICT demand across Europe. The Netherlands (1.1 million) and Poland (0.9 million) follow, showing significant demand relative to their population size.

Figure 3. Top 10 countries by ICT job advertisements (2020–2025)



Cross-tabulation of top roles by top five countries

Table 1 demonstrates the distribution of leading ICT roles within the five countries with the highest demand. The United Kingdom shows a strong combination of software developers (1.74 million) and systems analysts (0.89 million), complemented by a substantial demand for ICT support technicians (0.63 million). Germany and France both display particularly strong demand for systems analysts (1.37 million and 1.23 million respectively), reflecting the importance of systems integration and design in their economies.

Table 1. Cross-tab of roles by top 5 countries (2020–2025)

Country	Role	OJAs
UK	Software developers	1 744 234
UK	Systems analysts	886 974
UK	ICT user support technicians	634 448
DE	Systems analysts	1 372 061
DE	Software developers	1 269 491
DE	Systems administrators	686 225
FR	Systems analysts	1 229 278
FR	Software developers	962 022
FR	ICT user support technicians	311 265

NL	Software developers	323 367
NL	Systems analysts	287 345
NL	Web and multimedia developers	196 195
PL	Software developers	344 265
PL	Systems analysts	189 043
PL	Web and multimedia developers	132 676

Comparative analysis of transversal skills across ICT occupations

To complement the analysis of overall demand trends, the dataset of OJAs from Q2 2024 to Q1 2025 was used to identify the most frequently mentioned skills within four ICT occupational groups: ICT Service Managers, Software and Applications Developers and Analysts, Database and Network Professionals, and ICT Operations and User Support Technicians. For each group, the top five skills were extracted based on their frequency of mentions, ensuring comparability across roles.

ICT service managers

The skill profile of ICT managers shows a stronger orientation toward leadership and organisational competences than other groups. Alongside analytical and problem-solving abilities (accessing and analysing data; developing solutions), managers uniquely emphasise supervising teams and complying with operational procedures.

Software and applications developers and analysts

Developers and analysts present a more mixed profile, where technical skills dominate but transversal competences remain prominent. Analytical thinking (accessing and analysing data), collaboration (using digital tools for teamwork), and problem-solving (developing solutions) are recurrent. Unlike managers, however, leadership does not appear among their top skills. This indicates that developers and analysts operate primarily in team-based and problem-oriented environments, where adaptability and integration with business processes matter more than direct supervision.

Database and network professionals

For database and network specialists, the emphasis shifts toward consultancy and precision. While technical operations such as setting up computer systems remain central, transversal skills include analytical management of digital data and collaboration using digital tools. The absence of leadership or customer-facing competences in their top skills suggests that these roles act as technical advisors and infrastructure stewards, ensuring reliability and security rather than leading teams or directly interacting with end-users.

ICT operations and user support technicians

Support technicians reveal the strongest orientation toward interpersonal and communication competences. In addition to problem-solving (developing solutions) and analytical tasks (data management), their top skills emphasise collaboration and user interaction (using digital tools for teamwork). These competences align with their frontline role in assisting end-users.

Share of transversal skills across ICT occupations

- ICT service managers. Top transversal skills include personal development (28.6-26.5%), teamwork (24.2%), efficiency (19.8%), and leadership (15.1%). This shows a strong managerial profile, where self-improvement, coordination, and organisational efficiency are prioritized alongside team leadership.
- Software and applications developers and analysts. The leading transversal competences are adaptability (28.1%), leadership/responsibility (26.4%), problem-solving (26.0%), and maintaining a positive attitude (24.3%). Developers thus combine technical depth with adaptability and problem-solving, but unlike managers, their leadership is framed as responsibility-taking rather than team supervision.
- Database and network professionals. The most frequent transversal skills are adaptability (29.1%), teamwork (23.6%), and coaching/consulting (23.2%). This confirms their hybrid role as technical experts and advisors, where working in teams and guiding others are critical alongside technical reliability.
- ICT operations and user support technicians. Soft skills dominate even more clearly: adaptability (33.1%), coaching/consulting (27.7%), and teamwork (12.7%). These profiles highlight frontline interaction, where communication, service orientation, and resilience under user-facing conditions are decisive.

Cross-group comparison

When comparing the four groups, several transversal competences emerge as common threads, yet with different degrees of importance. Adaptability is the most universal, ranging from 28.1% of mentions among developers to 33.1% among support technicians, reflecting the need to cope with rapid technological and organisational change. Teamwork is a second cross-cutting competence, appearing strongly for managers (24.2%) and network specialists (23.6%), but less so for technicians (12.7%), where interpersonal coaching and consulting (27.7%) dominate instead. Developers stress problem-solving, managers efficiency and leadership. This distribution indicates that although transversal skills are present across ICT roles, their weighting aligns

closely with occupational responsibilities: managers stress coordination and direction, developers balance technical depth with adaptability, network specialists adopt advisory and collaborative functions, and technicians emphasise service, communication, and resilience in user-facing contexts.

DISCUSSION

The labour market requires a layered skill structure where software development and analytical competences form the backbone, supported by administration, operations and management roles that keep systems functional. This mix aligns with the European Skills Agenda, which stresses that transversal competences must complement technical ones to achieve sustainable digital growth.

Geographical patterns reveal both concentration and disparity. The dominance of the United Kingdom, Germany and France reflects their economic scale but also creates regional inequalities that risk slowing balanced digital development. Variation in role emphasis reflects national approaches, with Germany and France prioritising analysts and the UK support roles. These variations show why training and upskilling initiatives must adapt to national contexts even while using common European frameworks such as ESCO.

From a policy perspective, the evidence indicates the need to expand software and systems competences while ensuring a sufficient pipeline of operational and managerial skills. It also highlights the importance of strengthening transversal skills tailored to occupational roles.

CONCLUSION

This study analysed ICT labour market demand in Europe between 2020 and 2025 using online job advertisements. Four main results emerge. Demand rose steadily and accelerated after 2021, confirming the structural role of digitalisation. Developers and analysts remain central, but support, administration and management roles are also indispensable, showing the layered character of digital ecosystems. Demand is geographically concentrated in the United Kingdom, Germany and France, creating disparities that may shape mobility and training. Transversal competences vary systematically by occupation: managers emphasise leadership and efficiency, developers combine adaptability and problem-solving, network professionals stress advisory and collaborative functions, and support technicians highlight communication and resilience.

Taken together, these findings underline that ICT professionalism depends on more than technical proficiency. It requires role-specific mixes of soft skills that enable effectiveness in different contexts. Education and training policies should therefore balance technical depth with

differentiated transversal competences. Leadership and strategy are vital for managers, adaptability and teamwork for developers, advisory skills for network professionals, and service orientation for technicians. Aligning these needs will be crucial for meeting the EU's Digital Decade targets and preparing Europe's workforce for emerging challenges such as artificial intelligence, cybersecurity and green ICT.

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Digital competence and skills

Certifying Teachers' Digital Competences According to DigCompEdu

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ABSTRACT

This article presents AICA's proposal for a certification of teachers' digital competences based on the European framework DigCompEdu. The analysis begins with an overview of the current situation in Italy regarding the use of digital technologies in education and an introduction to the DigCompEdu framework. Subsequently, after describing the self-assessment tool SELFIE for Teachers, designed to support teachers in reflecting on their digital competences, the architecture of the AICA certification is outlined. The certification is structured into two distinct examinations: the first covering competence levels from A1 to B2, and the second dedicated to the advanced levels C1 and C2.

Keywords: DigCompEdu, Teachers' training, Certification, Digital education, Digital competences

INTRODUCTION

Artificial intelligence is already reshaping the way we learn and teach, much as digital technologies have progressively done over the past forty years. As McLuhan pointed out: "We shape our tools and thereafter our tools shape us" [1]. "... the artifact is seen to be not neutral or passive, but an active logos or u0erance of the human mind or body that transforms the user and his ground" [2].

Digital technology has redefined many of our professional and social practices. This is not the first time a technological innovation has significantly impacted teaching and learning: one can recall the invention of writing, the printing press, and calculation tools from the abacus to calculators,

the introduction of blackboards in the 19th century, or audiovisual technologies such as radio, projectors, and documentary films in the 20th century.

DigCompEdu does more than simply list the “digital skills” teachers should master; it outlines a new professional profile for educators, embedded within a new school model, and above all, aligned with new objectives. Indeed, the knowledge, skills, and attitudes required of 21st-century citizens are fundamentally different from those of the past.

DIGITAL TECHNOLOGIES AND EDUCATION – THE ITALIAN CONTEXT

AICA has been engaged since the 1980s with the impact of digital technologies — then referred to as informatics — on education. According to Alfio Andronico, the starting point was 1984, with the first national census on “educational software” [3]. Since then, a series of initiatives culminated in Didamatica - DIDAttica con l’inforMATICA - the AICA annual conference on IT in education which held its 37th edition last November.

Over time, attention shifted from software experiments towards three main strands:

- promoting students’ digital competence (one of the eight key competences for lifelong learning),
- developing computational thinking (more recently referred to as coding),
- employing digital tools and environments to foster pedagogical innovation, personalization, and inclusion.

Since the late 20th century, Italy has launched several initiatives both for teacher training and for equipping schools with digital devices and infrastructure. These included the National Informatics Plan (PNI, 1985), the LIM Action (Interactive Whiteboards, 2008), Cl@ssi 2.0 (2009), Scuol@ 2.0 (2011), and the establishment of Digital School Centers (2012).

A milestone was the 2015 **National Digital School Plan** (Piano Nazionale Scuola Digitale, PNSD) [4] - skill a key reference - “a policy document... for the launch of a comprehensive strategy for the innovation of the Italian school system and for a new positioning of its educational system in the digital era.” It introduced the role of Digital Animator in every school, later supported by Digital Animator teams.

The COVID-19 pandemic (2020) accelerated digital adoption: online tools became essential to ensure continuity of teaching and learning. Building on that experience—with both its strengths and weaknesses—the Ministry of Education (now MIM, Ministry of Education and Merit)

launched the Scuola 4.0 plan, linked to the National Recovery and Resilience Plan (PNRR), aiming to modernize education through investments in infrastructure and training.

The Osservatorio Scuola Digitale Report 2024 [5], involving 96% of schools, highlighted key findings:

- **Connectivity:** while nearly all schools are connected to the internet, disparities remain between urban and rural areas; Wi-Fi coverage is often incomplete.
- **Devices:** most schools have labs and mobile devices, but access is uneven; many report difficulties in keeping devices updated and ensuring replacement cycles.
- **Teaching and digitalization:** 94% of schools conduct activities to develop students' digital skills (coding, robotics, digital citizenship). Innovative methods such as flipped classrooms and collaborative learning are expanding, and blended learning is becoming consolidated. Digital tools are also perceived as instruments of inclusion, though access barriers persist.
- **Teachers' competences and training:** most teachers view digital technologies positively. Many have basic competences, while advanced skills (data analysis, complex content creation, AI use, cybersecurity) are less widespread. Training has increased, though teachers call for more practical and targeted courses. Many perceive themselves as "intermediate": aware of the potential of digital technologies, but not always able to fully exploit them.

However, there are reasons to suspect that the report presents an overly optimistic view: innovative practices often concern only a subset of teachers, and training alone does not guarantee either application or competence development.

THE DIGCOMPEDU FRAMEWORK

"The objective of the DigCompEdu framework ... is to reflect on existing instruments for educators' digital competence and to synthesize these into a coherent model that would allow educators at all levels of education to comprehensively assess and develop their pedagogical digital competence" [6].

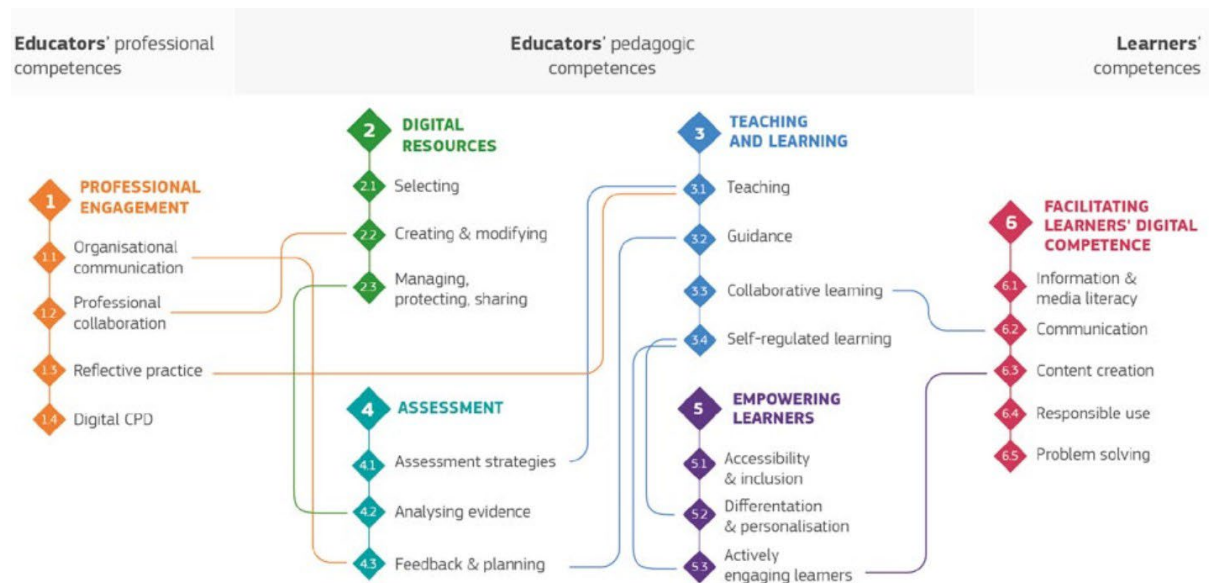
Released in 2017, the framework - see Figure 1 - identifies three domains of professional practice, six areas of competence, and 22 competences in total.

- Left, the "Educators' professional competencies" related to Professional Engagement (Area 1). This area concerns the use of digital technologies for communication and collaboration with colleagues, students, parents, and others, as well as for learning. It emphasizes the importance of teachers reflecting, individually and collectively, on their teaching practices,

critically evaluating the effectiveness and appropriateness of their digital teaching strategies, and actively working to develop them further.

- In the center, the "pedagogical competencies" with 4 areas of competence:
 - Digital resources (Area 2),
 - Teaching and learning (Area 3),
 - Assessment (Area 4),
 - Empowering learners (Area 5).
- On the right, the "Learners' competencies": Facilitating learners' digital competence (Area 6) indicates that teachers must facilitate the development of their students' digital skills as defined by the 5 areas of the DigComp Framework [7].

Figure 1. Areas and competences of the DigCompEdu framework from [6], reuse is authorised provided the source is acknowledged)



Comprising 22 competences grouped into 6 areas, the framework illustrates that, as in most professions, digital technology permeates all aspects of teachers' practice, enhancing their effectiveness and efficiency while simultaneously reshaping and transforming them. At the same time, it underlines that teaching cannot be reduced to the mere 'transmission' of knowledge; rather, teachers must address key issues such as collaborative and self-regulated learning,

personalized teaching, inclusion, and active engagement of students. In this regard, it emphasizes that "*teachers need to update their competence profiles for 21st-century challenges*" [8]. Proficiency levels are aligned with the CEFR (Common European Framework of Reference for Languages) model: A1 (Newcomer), A2 (Explorer), B1 (Integrator), B2 (Expert), C1 (Leader), C2 (Pioneer).

In Italy, DigCompEdu has been adopted as a policy reference: it is explicitly mentioned in the National Digital School Plan (2016), in the Guidelines for Integrated Digital Teaching (2020), and in the School 4.0 plan (2022).

SELFIE FOR TEACHERS

In 2020, the Joint Research Centre (JRC) of the European Commission launched SELFIE for Teachers, a free multilingual self-assessment tool based on DigCompEdu. By June 2025, about 270,000 teachers, mostly from Spain, Greece, Italy, Portugal, and Germany, had used the tool [9].

The tool comprises a guided reflection lasting about 25 minutes, followed by detailed feedback highlighting strengths and weaknesses across DigCompEdu areas. Its purpose is to support targeted professional development planning, in line with DigCompEdu competences 1.3 (Reflective practice) and DigComp 5.4 (Identifying digital competence gaps) [10].

SELFIE for Teachers is useful both at the individual and institutional level. For example, the University of Palermo used it to assess the digital competences of teachers in training. Results showed relatively good performance in organizational communication (46%) and professional collaboration (40%), but significant weaknesses in advanced areas, such as computational thinking (26%) and digital content creation (29–34%). Competences related to accessibility, inclusion, and digital literacy were among the weakest [11].

However, SELFIE for Teachers is not a certification tool: it does not formally attest competences, leaving an unmet demand for certification.

THE AICA DIGCOMPEDU CERTIFICATION

Italian school authorities have immediately indicated DigComp and DigCompEdu as key reference points to be adopted for teacher training. A turning point was the 2019–2021 National Collective Labour Agreement (signed in January 2024), which introduced the *International Certification of Digital Literacy* (CIAD, this is the 'title' required by the Italian Ministry of Education) as mandatory for updating administrative, technical, and auxiliary (ATA) staff registers. Certifications must be recognized by Accredia, Italy's national accreditation body, as aligned with the DigComp 2.2

framework. This represents the **first mandatory digital competences certification in public administration**. It is reasonable to expect that a similar requirement will soon be extended to teachers, in the form of a DigCompEdu-based certification. Accredia has already issued a technical circular confirming DigCompEdu as the official reference framework for certifying educators' digital competences.

AICA - Associazione Italiana per l'Informatica e il Calcolo Automatico, Italian member of CEPIS - has therefore developed, and is accrediting with Accredia, a DigCompEdu certification. The framework defines areas, competences, and proficiency levels, but does not provide lists of knowledge and skills. We have therefore developed a set of Learning Outcomes (LO) corresponding to the 22 competences, divided into knowledge and skills, and classified by level.

The syllabus includes 330 LOs: 62 for Area 1, 46 for Area 2, 65 for Area 3, 43 for Area 4, 46 for Area 5, and 68 for Area 6. Of these, 50 are at level A1, 56 at A2, 60 at B1, 69 at B2, 50 at C1, and 45 at C2. For example:

- “Knowing asynchronous communication tools and services: digital gradebook (the Italian electronic school register), email, virtual classrooms, social media groups” (knowledge item, A1, competence 1.1 Organizational communication).
- “Verifying the reliability, quality, and relevance of digital resources, using both AI-based tools (fact-checking, sentiment analysis, source evaluation) and traditional methods (author credentials, trusted sources, publication date), ensuring accuracy and currency” (skill item, B2, competence 2.1 Selecting digital resources).
- “Creating and moderating discussion forums or digital boards to enable students to interact asynchronously, fostering reflection and exchange of ideas” (skill item, B2, competence 3.3 Collaborative learning).

Based on the syllabus, a database of exam questions was designed, corresponding to all 330 identified learning objectives (LOs). Two exams were subsequently designed and implemented.


The first exam covers levels A1 to B2. The questions are presented in progressive levels: it begins with A1 level questions for each skill within each area. Then, for the areas where the passing threshold has been met, the exam proceeds with A2 level questions for all items in that area, and so on up to level B2. At the conclusion, a certificate - see Figure 2 - is issued that indicates the level achieved in each area and also provides an overall "average" proficiency level.

Candidates who achieve at least an average level of B1 in the first exam can proceed to the second exam, which is dedicated to the C1 and C2 levels. If the candidate has already achieved a B2 level in all areas, the exam will start with C1 questions for each skill. In the areas where a passing grade is achieved, it will proceed with C2 questions. Conversely, if a candidate enters the exam without having reached the B2 level in one or more areas, the exam will begin with questions for the levels not yet passed, followed by the C1 questions. At the end, the same type of certificate is issued, updated to show the level achieved in each area.


Prior to its full implementation for all teachers, the certification will be piloted in October 2025 with a subset of approximately 300 educators who have participated in AICA's DigCompEdu trainer courses in recent years.

Thanks to the European scope of the framework, the AICA DigCompEdu certification is easily transferable and can be applied not only within Italy but also internationally.

Figure 2. DigCompEdu certificate



Certificato DigCompEdu



The Digital Skills Standard

Name Surname

Nato/a il 29/02/1971 a Chiavari

C.F.: AAABBB00C12D123E

in conformità al "Regolamento per le certificazioni delle Competenze Digitali" di AICA, ha dimostrato di possedere competenze conformi a DigCompEdu, con i seguenti livelli di padronanza, per le aree qui di seguito specificate

AREE DI COMPETENZA DIGCOMPEDU	1 COINVOLGIMENTO E VALORIZZAZIONE PROFESSIONALE	2 RISORSE DIGITALI	3 PRATICHE DI INSEGNAMENTO E APPRENDIMENTO	4 VALUTAZIONE DELL'APPRENDIMENTO	5 VALORIZZAZIONE DELLE POTENZIALITÀ DEGLI STUDENTI	6 FAVORIRE LO SVILUPPO DELLE COMPETENZE DIGITALI DEGLI STUDENTI
LIVELLO RAGGIUNTO DAL CANDIDATO	B2 - ESPERTO	A1 - NOVIZIO	B1 - SPERIMENTATORE	B2 - ESPERTO	A2 - ESPLORATORE	B2 - ESPERTO

e pertanto la persona è certificata secondo il profilo

Digital Competence Framework for Educators DigCompEdu

al livello B1 di padronanza generale delle competenze


IT-1234567

Numero


Data di prima emissione: 02/07/2025

Data di emissione corrente: 02/07/2025

Data di scadenza: 02/07/2029



Antonio Piva
Presidente AICA



Per verificare l'integrità dei dati riportati
nel presente certificato usare il qr-code qui a fianco.
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SC 24-6 rev. 1 del 03/04/2023A

CONCLUSION

Digital technologies have profoundly transformed society, the workplace, and the ways in which young people learn and construct knowledge. Education must therefore redefine its objectives and adopt pedagogical practices better suited to current and future challenges. Many teachers and schools have already embarked on this transformation, but systemic support is needed.

The advent of Generative Artificial Intelligence represents a qualitative leap, capable of reshaping roles, competences, and educational relationships.

In this context, developing a certification of teachers' digital competences assumes strategic importance: it is not merely a matter of technical skills, but of recognizing a broader set of cultural, methodological, and ethical competences required to guide schools through change. Digital transformation must be understood not as a simple replacement of tools (for instance, the adoption of the digital gradebook instead of the traditional paper-based one), but as a paradigm shift reimagining teaching, learning, and the entire educational experience.

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EAGLE: Bridging the Digital Skills Gap for European SMEs

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INTRODUCTION

The EAGLE project (CovEring the training Gap in digital skills for European SMEs manpower) [1] (Ref. 101100660) is funded under the European Commission's Digital Europe Programme (DIGITAL) [2]. Its consortium comprises 5 higher-education institutions (Universidad de Burgos (UBU), Univerzita Mateja Bela (UMB), Turku UAS (TUAS), Technical University of Ostrava (UVT-TUO), University of Limerick (UL)), one Centre of Excellence in Cybercrime (L3CE), an ICT-specialized SME Vernian RTI and key business associations from Spain, Slovakia, Ireland and the EU's Digital Innovation Hubs. EAGLE's ultimate goal is to deliver six high-quality crash courses in industrial robotics, data analytics, blockchain, cybersecurity and smart energy systems, tailored to the needs of SMEs across Europe.

PROCESS/WORK PACKAGES

EAGLE is structured into four interrelated work packages [3]:

WP1: Project Management and Coordination. Covers administrative, legal, financial, and liaison tasks with the European Commission to ensure the smooth governance of the project.

WP2: Needs Analysis and Course Design. Within this work package, the consortium conducted focus groups and surveys across seven countries to map SMEs' digital skill gaps. Six bespoke upskilling courses were designed, expert peer reviews (industry/academic reviewers) were performed, and pilot tests with SME employees were conducted to refine the content.

WP3: Course Delivery. Enrolment was managed using transparent criteria (age ≥ 16 years, SME affiliation, and commitment to completion). Six courses were delivered in blended and online formats, totalling 12–150 hours each.

WP4: Communication and Dissemination. This work package included the launch of a dedicated portal, EU Digital Skills & Jobs Platform listings, and social media campaigns. This work package included the launch of a dedicated portal, EU Digital Skills and Jobs Platform listings [5], and social-media campaigns. The collected participant feedback and course metrics were used to iterate the course design process.

MOST RELEVANT RESULTS

The characteristics of each course are briefly described in Table 1. The offer is quite heterogeneous, as each partner university has tailored the course design to the requirements of the SMEs present in each region.

Table 1. Description of the courses

Course ID	Title	Duration (hours)	Language	HEI	Modality
1	Digitalisation of Business & Industry Processes – Professional Diploma	130	English	UL	Presential
2.1	Boost your productivity and work efficiency by using Large Language Models like ChatGPT and Bard	5	Spanish	UBU	Hybrid
2.2	Introduction to Big Data and Business Intelligence	16	Spanish	UBU	On-line
2.3	Enterprise Machine Learning based on R. Learn how to get the most out of your data.	30	Spanish	UBU	On-line
2.4	IoT and Intelligent Systems in Industry 4.0	30	Spanish	UBU	Hybrid
2.5	Application of optimization techniques in products, processes and business resources	8	Spanish	UBU	Hybrid
2.6	Basic control in the industry. Learn how to tune a PID controller.	8	Spanish	UBU	Hybrid
2.7	Industrial robotics	16	Spanish	UBU	On-line
3	Utilizing the potential of energy and technological systems	25	Czech	VSb-TUO	Presential
4	From Cyber Awareness to Resilience	50	Finnish + English	TUAS	Presential
5	Cybercrime, Cyberthreats and Cybersecurity	12	Lithuanian + English	L3CE	On-line
6	Blockchain	50	Slovakian + English	UMB	Hybrid + Online

As for general aspects, each course is usually delivered in the native language of the country, with few exceptions, and the preferred modes of delivery are hybrid or completely online. An

extended course offered by UBU was divided into separate micro-courses to better adapt to the time constraints of SMEs staff.

Table 2 summarises the project KPIs after at least two editions of most courses and two complete reporting periods. Courses have attracted strong demand across all six modules. The overall completion rate of 72% confirms feasibility in SME contexts, while a 95% satisfaction rate (out of 242 returned questionnaires overall) indicates the high perceived relevance of the training content.

Table 2. Figures of attendance and success rates of each of the courses

Course ID	Editions Reported	No. of Applications	No. of Participants	No. of Successful Participants	No. of SME's from Successful Participants
1	3	159	54	42	31
2.1	1	45	33	21	15
2.2	2	48	38	14	5
2.3	1	59	15	12	6
2.4	1	28	24	18	7
2.5	2	29	16	6	7
2.6	2	9	9	9	9
2.7	2	81	62	36	19
3	4	113	106	76	76
4	2	54	52	51	36
5	3	471	215	155	113
6	4	248	163	123	75
TOTAL	-	1344	787	563 (72%)	399

As for findings for future reference, some courses were particularly well received for the depth of their content, despite the need for an extended commitment for their completion, such as Course ID 1 (Table 1). Others combined the relevant topic of cybersecurity with a special emphasis on both accessibility (online and in English) and dissemination using paid campaigns and international dissemination platforms, such as the Digital Skills & Jobs Platform [5] (Course ID 5), achieving a significant number of applications and attendees from different European countries. Challenges remain in collecting feedback and tailoring shorter modules for late adopters of digital transformation technologies [4]. Future iterations will integrate better analytics on learner engagement and fine-tune the admission criteria to balance access and capacity.

The project conducted an internal survey to assess its development and collect opinions from the participating organisations, including 27 staff members from all partners with different roles (management, dissemination, training design, etc.). The results also represent an overall positive effect on the participant organisations, including a tighter relationship with SMEs and other

European HEIs and institutions, while pointing out future challenges for the digitalisation of European SMEs, such as the difficulty in attracting some sectors to reskilling activities.

CONCLUSION AND ACKNOWLEDGMENT

EAGLE has successfully co-designed and piloted six specialised digital-skills continuous learning courses aligned with SME needs in six EU countries. Interim KPIs demonstrate robust uptake (1.355 applications) and high satisfaction (95%), underscoring the consortium’s ability to bridge the digital skills gap in the EU labour force. Next steps include expanding outreach to under-represented regions and integrating internal survey insights to refine course delivery.

Some of the courses (IDs: 1, 2.2, 2.3, 2.4, and 2.7 in Table 1) are currently offered as micro-credentials by the corresponding universities, paving the way for their continued delivery in the future. The EAGLE consortium has successfully established strong collaborations with other EU-funded projects, fostering synergies that empower European SMEs to enhance their competitiveness and resilience. An example is the collaboration between the EAGLE and CYSSME [6] projects which will facilitate the continuation of the delivery of the contents of Course ID 5.

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Course design for heterogeneous learning groups: The DigiKoSMos project

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INTRODUCTION

The DigiKoSMos project (*Digitale Kompetenzen für Selbstbestimmung und Mobilität stärken*) aims to develop face-to-face and online courses to promote digital competences among refugees. On an individual level the focus is on enabling people to increase their global employability and individual self-efficacy. At the societal level, the project thus contributes to the development of a workforce in a data-driven digital economy. Since the project started in July 2024 a course concept was developed in terms of content and didactics. Also, several first face-to-face courses were held on site. The paper describes the course design process and identifies lessons learned from theoretical and practical educational work.

PROCESS/WORK PACKAGES

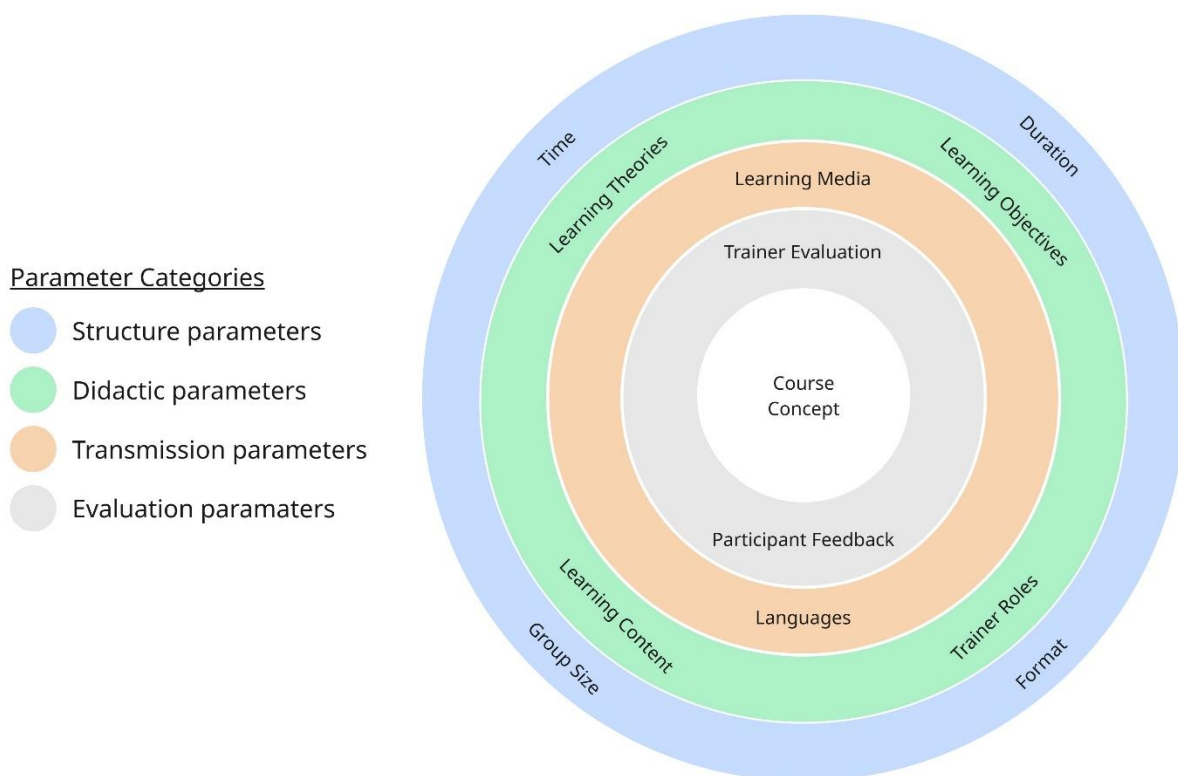
The methodological approach is based on a **literature-based analysis** of the target group's needs and best practice insights. A subsequent **design of a suitable teaching arrangement** follows these findings. The process describes how an educational course concept is defined for a specific but elusive and diverse target group. Two steps were taken to create a suitable course offering: 1. **Literature-based research** on target group-oriented teaching development. 2. **Definition of relevant parameters** for designing the course structure.

MOST RELEVANT RESULTS

The research process, which also included interviews with reception center staff, yielded insights into motivational factors and conditions for success in adult education programs (e.g. learner-centered approach [1]).

Recommendations on how to embed employability measures in to the course structure were captured [2] and learning content was filtered from three digital competence frameworks [3]; [4]; [5]. For examining participants' prior knowledge and learning outcomes the DigCompSat served as a basis for the evaluation process [6]. Through analysis four parameter categories were identified that shape the course concept: structure, content/didactics, transmission, evaluation. Figure 1 shows these four categories each with the relevant parameters.

Figure 1. DigiKoSMos parameters for course conception, further developed scheme based on "The six didactic questions" by Schlutz, cited by Gundermann. [7, p. 2]



Course time, duration and format as well as group size were identified as **structure parameters**. They defined a teaching and learning setting by specifying a course structure. Whereas time and duration parameters vary between courses in the project depending on venue availability, the format of face-to-face group courses and a group size of at least ten students are consistent throughout the courses. On-site learning formats are known to be a valuable setting to provide real time feedback and exchange between learners and teachers. The **didactic parameters** of learning theories, objectives and content as well as trainer roles were considered to ensure a common understanding of the teaching approach. Learning theories common in adult education such as pragmatism built a foundation for conceptualizing

the courses. The objectives are digital competencies based on DigComp and are delivered through a mix of input, explorative tasks, discussions and group exercises. Trainers switch in their roles mainly between instructors, moderators and learning companions. This enables the acquisition of competences by transferring knowledge, practicing abilities, and encouraging reflection on attitudes.

Teaching media and course language were the prioritized **transmission parameters** in the project. These parameters were implemented by selecting a blend of analogue and digital learning materials such as collaborative whiteboards and worksheets, which were then translated into seven different languages. It supports accessibility to the courses' content for most participants.

To secure continuous enhancement of the course concept both trainer evaluation and participant feedback were chosen as **evaluation parameters**. In the project data from trainers documenting their techniques and media as well as verbal and written feedback from participants is taken into consideration when working on the course concept.

The selected parameters are **continuously reviewed**, and their incorporation into the courses is adjusted whenever actual course conditions change the requirements. Other aspects, such as project specifications from funding offices, remain unchanged. This development of course concept parameters shows that a static mostly theory-driven top-down design is insufficient in means of the project's educational focus.

CONCLUSION AND ACKNOWLEDGMENT

Our findings contribute an **agile theory-practice model of course conceptualization** for heterogenous learning groups and specifically in the case of working with refugees living in reception centers. The results show that the course design process involves more complex and flexible parameters than initially assumed. To create teaching arrangements that meet specific needs, it is necessary to have an understanding of the target group built on experience and interaction more than theoretical studies. Just as important is a research team that is open to repeatedly questioning what is believed to be true and trying out new things. Even though a scientific evaluation of participant satisfaction is yet to be completed in the project, the here discussed model serves as a well-functioning orientation base for course conceptualization.

DigiKoSMos is funded by the European Union through the Asylum, Migration and Integration Fund and the Rhineland-Palatinate Ministry for Women, Family, Culture, and Integration.

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AI4Everyone: Bridging the Gap Between Smart Technologies and Society

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INTRODUCTION

We live in the era of the Fourth Industrial Revolution [1], which has rapidly reshaped the global economy. Today, the largest companies by market value focus on IT and AI—a stark shift from two decades ago¹. AI now touches everyday life, from drafting texts with ChatGPT and using Alexa for home automation, to relying on recommender systems and facial recognition. Yet, across Europe, just over 50% of people have adequate digital skills, with significant national disparities [2] and polarized trust [3] in emerging technologies. Although, Europe has addressed these challenges through regulations like the GDPR², AI HLEG³ ethical guidelines, and the EU AI Act⁴, building a trustworthy AI ecosystem requires not only regulation but also education and awareness. Citizens who are informed can better develop appropriate trust and critical understanding of AI [5]. Existing AI courses, mostly aimed at computer science students [4], are largely inaccessible to the general public, despite daily AI interactions. The AI4Everyone project seeks to fill this gap by providing educational resources that empower people to engage with AI responsibly and critically.

The AI4Everyone project, funded by the EU's *Erasmus+ Programme* under agreement 2025-1-CY01-KA220-HED-000364525, brings together universities from five European countries—Open University of Cyprus (Cyprus) - coordinator, University of Trento (Italy), University of Koblenz

¹ *Forbes.com*, 2023. <https://www.forbes.com/consent/ketch/?toURL=https://www.forbes.com/lists/global2000/>

² <https://eur-lex.europa.eu/eli/reg/2016/679/oj/eng>

³ <https://digital-strategy.ec.europa.eu/en/policies/expert-group-ai>

⁴ <https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai>

(Germany), Aalborg University (Denmark), and the Polish-Japanese Academy of Information Technology (Poland)—to address the pressing need for citizens to gain a deeper understanding of AI's role in everyday life within today's data-driven paradigm. By examining the ethical and social implications of AI's widespread use, the project seeks to empower learners to make informed decisions, critically evaluate AI applications, and understand both their potential benefits and inherent risks. To achieve this, AI4Everyone primarily targets higher education students, faculty, and administrative staff across partner universities, engaging non-AI experts through structured courses and training – at least 1000 participants expected to be involved. Beyond the consortium, it extends to citizens across Europe, promoting AI literacy and awareness through the curriculum, MOOC, and dissemination activities. In this line, the project pursues four interconnected objectives: i) it introduces a framework to assess AI awareness and readiness levels among institutions and individuals through quizzes, surveys, and validated scales, enabling both an initial baseline assessment and periodic evaluations to measure changes over time; ii) designs and implements a modular educational resource toolset, consisting of online and blended learning courses, educator training sessions, and written guides to support integration into higher education settings among students, administrative staff, and non-IT faculty; iii) develops a Massive Open Online Course (MOOC) as an independent open educational resource, extending access to flexible learning opportunities for staff members and audiences beyond the project consortium; iv) integrates hands-on activities into both the educational toolset and the MOOC, providing learners with practical experience in using AI-enabled applications to generate, collect, and analyze data, while reflecting on how such technologies influence everyday life.

PROCESS/WORK PACKAGES

The AI4Everyone project is structured into five work packages (WPs) that ensure the design, implementation, and dissemination of innovative educational resources for AI literacy.

WP1 is focusing on project management. WP2, establishes the foundation for subsequent activities by conducting large-scale online studies across partner institutions. These studies assess AI awareness, competence, and technology readiness among the target groups using validated instruments. Digital tools are also deployed to create hands-on exercises that function both as assessment mechanisms and embedded learning activities. Results will be consolidated into the AI4Everyone Assessment Toolbox, supporting initial and post-course evaluations.

Building on these insights, WP3 develops and implements the AI4Everyone Course Curriculum, an interdisciplinary program combining online and blended learning, problem-based learning (PBL), and exercises. Three iterations are planned: an online pilot with students, a blended learning version at a Winter School, and a final iteration targeting faculty and administrative staff.

WP4 extends the curriculum into a MOOC, offering an open, fully online resource accessible to diverse audiences beyond the consortium. Designed to require no prior technical expertise, the MOOC includes readings, videos, and interactive exercises that highlight AI's role in daily life and its ethical implications. Evaluation will use the Assessment Toolbox, quizzes, and learner interviews, with certificates provided for participants meeting the course requirements. Finally, WP5 ensures broad dissemination of results through institutional events, staff training sessions, and the Winter School, strengthening the project's sustainability and impact.

MOST RELEVANT RESULTS

The AI4Everyone project will deliver significant results across its core work packages. The AI4Everyone Assessment Toolkit is expected to assess and enhance AI competence and technology readiness. The flexible, modular AI course in online, blended, and MOOC formats, supported by the necessary infrastructure on the Protea platform⁵, will engage diverse audiences through instructional material, PBL, and digital exercises. AI4Everyone will develop a fully online MOOC tailored to diverse audiences.

Furthermore, the project is expected to generate significant impact at local, regional, national, and European levels by advancing AI education and digital literacy. Locally and regionally, it will enhance AI-related skills among different societal groups, particularly in countries, where digital skills are limited and public attitudes toward AI are often negative. Partner institutions will integrate the project curriculum into their programs, while local organizations and communities will gain access to open educational resources, fostering informed and responsible AI use. Nationally, the project will support the development of AI-focused curricula and professional training through collaborations with educational authorities, training institutions, and policymakers, while its MOOCs will facilitate adoption beyond the consortium.

CONCLUSION AND ACKNOWLEDGMENT

The AI4Everyone project advances the integration of digital skills and competences into education and training by extending AI literacy beyond higher education curricula through open-access resources. Through large-scale assessments of digital skills across countries, regions, and sectors, it provides valuable insights for tailoring education to diverse needs while ensuring that digital competences are accessible and measurable for all. This project is co-funded by the EU's Erasmus+ Programme under agreement 2025-1-CY01-KA220-HED-000364525 (AI4Everyone).

⁵ The Protea platform is Moodle-based, built and maintained by the Cyprus Center for Trustworthy AI, Open University of Cyprus.

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PINNACLE: Public Engagement in AI Evaluation for Education and System Benchmarking

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INTRODUCTION

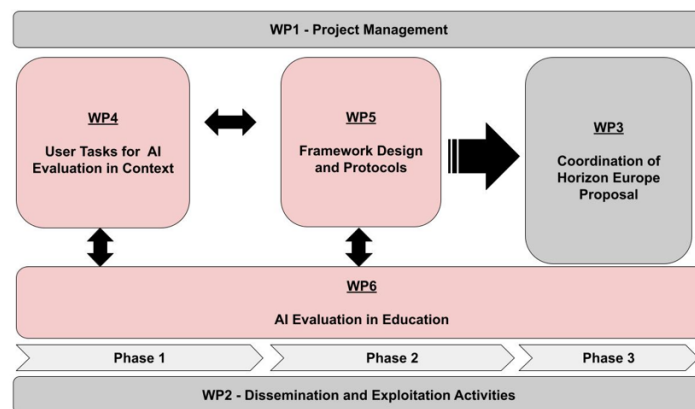
The rapid deployment of AI systems across education, work, and public services is transforming the landscape of digital skills, expanding them to include information and AI literacy [1]. Developing AI literacy is increasingly recognized as a core component of digital competence, encompassing not only understanding AI technologies but also critically evaluating AI applications and their societal impact [2], [3]. Traditionally, AI systems are evaluated through benchmarks, standardized tasks, datasets, and metrics, designed to measure system performance and properties such as safety, robustness, and fairness [4]. While these benchmarks are essential for assessing trustworthiness, they do not capture how real users perceive AI systems in practice [5]. Addressing this gap is essential not only for promoting responsible AI adoption but also for strengthening AI literacy [6]. The PINNACLE project (BRIDGE2HORIZON/0823E/0203), co-funded by the Cyprus Research and Innovation Foundation under the BRIDGE2HORIZON program, responds directly to this challenge by developing participatory AI evaluation, combining bottom-up (user-driven) and top-down (researcher-guided) approaches. Through structured tasks integrated into public AI education programs, PINNACLE enables users to engage with AI applications critically, evaluate their trustworthiness, and reflect on their own trust, thereby fostering AI literacy and providing actionable insights for both researchers and policymakers.

PROCESS AND WORK PACKAGES

The PINNACLE project is structured into six Work Packages (WPs) as depicted in Figure 1, organized into three interdependent phases: the design of user evaluation tasks, the

development of protocols and framework, and the integration of the activities into education alongside preparation for Horizon Europe proposal. WP1 and WP2 provide the backbone of the project, ensuring smooth coordination, quality assurance, and communication of the results. WP3 fulfills the BRIDGE2HORIZON objective by preparing and submitting a Horizon Europe proposal, consolidating the outputs of all activities and positioning the consortium for sustained participation in EU research. WPs 4-6 focus on the fundamental research that underlies the creation of user-centered AI evaluation methodology. WP4 conducts participatory design of evaluation tasks that are appropriate and interesting for the public, while WP5 focuses on the development of the framework, establishing the necessary protocols for collecting and aggregating data from the user-sourced evaluations, and the required analytics to produce insights. WP6 considers the integration of AI evaluation activities into our ongoing course “AI in Everyday Life” [7], [8]. Beyond the current course, WP6 designs additional educational initiatives, to foster a Participatory AI culture in the local community.

Figure 1. PINNACLE work packages and their interdependencies.



MOST RELEVANT RESULTS

Results to date

Building on the participatory evaluation framework developed in the PINNACLE project, the “AI in Everyday Life” course, offered since 2021 at the Open University of Cyprus, engaged participants in structured tasks to reflect on AI applications they use in daily life. In line with the project’s dual approach, participants completed bottom-up tasks - identifying AI-enabled applications independently, and top-down tasks - analyzing specific technologies aligned with weekly course topics. Each week, participants documented relevant applications, selected one for detailed evaluation, and assessed their trust on the application and its trustworthiness. Analysis of the collected logs shows that participants’ trust ratings were generally consistent with

their trustworthiness assessments, indicating appropriate alignment between perception and evaluated quality. Trust also proved to be dynamic, varying over time and across different AI technologies. Preliminary analysis also showed that the course and the tasks enabled participants to evaluate AI in their everyday life more critically and advance their AI literacy in general. These findings confirm that the structured, reflective tasks can effectively produce meaningful measures of perceived trust and trustworthiness in real-world contexts. Overall, these preliminary results demonstrate that the PINNACLE methodology not only supports user-centered AI evaluation but also fosters digital competence and AI literacy.

Expected Results

Building on the preliminary piloting of the evaluation tasks, PINNACLE expects to deliver additional outputs that extend the impact of these tasks. While initial work demonstrated the feasibility of embedding participatory evaluation tasks into educational settings, the project will refine these protocols and best-practice guidelines to support broader implementation across diverse classrooms and community contexts. The project will also produce expanded educational resources, including lesson plans, activity guides, and case studies, to facilitate the integration of bottom-up and top-down AI evaluation tasks into AI lifelong learning programs. Aggregated datasets from pilots across multiple initiatives will enable comparative analyses of trust, fairness, and autonomy perceptions, highlighting demographic and cultural variations. Interactive dashboards and visualization tools will make these insights accessible to educators, researchers, and policymakers.

CONCLUSION

The PINNACLE project advances AI literacy using participatory evaluation tasks with user-centered methodologies, enabling citizens not only to understand AI technologies but also to critically assess their trustworthiness. By integrating bottom-up and top-down approaches into educational programs, the project demonstrates that meaningful user perspectives can complement traditional technical benchmarks. These insights support responsible AI adoption, foster digital competence, and provide a scalable framework for embedding participatory AI evaluation into broader educational and community contexts.

ACKNOWLEDGMENT

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Accessible Robotics and AI Supporting Education

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INTRODUCTION

The convergence of AI and robotics represents a fundamental societal transformation. These disruptive technologies transcend all aspects of our life, as highlighted by the EU's GenAI4EU initiative [1]. This transformation creates both opportunities and challenges for European education systems. The presented project ARAISE (Accessible Robotics and AI Supporting Education) addresses these challenges by preparing educators and pupils for the ongoing AI revolution. It leverages robotics as the physical embodiment of AI, providing tangible ways to understand intelligent systems which are becoming ubiquitous in society. Within the scope of the project, equal access to AI and robotics education is ensured through an open-source robotics platform [2,3] through inclusive human-robot interaction interfaces, and through shareable robot kits that overcome financial barriers. The project fosters crucial digital competencies by teaching practical skills in robot programming, developing an understanding of human-AI collaboration, and creating awareness for ethical implications. As AI and robotics become integral to society, understanding these technologies will be as fundamental as digital literacy. By democratizing access to robotics education, the project aims to prevent digital divides and aims to ensure that all learners can participate in the AI-transformed future. The project is co-funded by the European Union and its consortium consists of academic-, research- and non-profit-organizations from Estonia, Bosnia and Herzegovina, Serbia and Austria.

PROCESS/WORK PACKAGES

In general, the project aims to democratize robotics and AI education by leveraging an open-source approach and addressing key barriers faced by teachers and pupils across different European countries and regions. It implements a European open-source robotics platform designed specifically for education combining professional-grade technology with accessibility. This approach bridges the gap between basic educational robots and industrial systems while creating a sustainable model for technology education. The integration of maker education with human-centered design, comprising multiple interaction modalities such as visual programming, gesture control, voice interaction, and traditional programming makes complex technology accessible to all skill levels. The robotics platform is based on *Robotont*¹, an open-source education and research omnidirectional mobile robot with ROS (Robot Operating System) support.

A novel robot kit lending system ensures that advanced technology is accessible to schools which usually can not afford expensive equipment. This approach is accompanied by the design and development of a curriculum framework including didactically sound ready-to-use learning materials based on the principles of constructionism [4] and aligned with the EU DigComp reference frame [5]. Piloting and implementing courses and workshops with teachers by applying a train-the-trainer methodology [6] ensures a broad and sustainable knowledge transfer.

The project is organized in five tightly integrated work packages, comprising project management WP1, curriculum and content development WP2, technology development WP3, train-the-trainer piloting and quality assurance WP4 as well as dissemination, communication and engagement WP5. The systematic evaluation is based on a proven mixed-methods approach which combines qualitative and quantitative measures. This comprises pre- and post-tests as well as interviews and observation notes. Gathered data will subsequently be analyzed using descriptive and inferential statistics as well as content analysis and triangulation [7].

MOST RELEVANT RESULTS, CONCLUSION AND ACKNOWLEDGMENT

The project started in September 2025 and is currently in its initial phase of setting the ground, performing related research and identifying relevant external stakeholders, including educational policymakers, school administrators, and curriculum experts. Through

¹ <https://robotont.ut.ee/en/> (last visited 03.10.2025)

comprehensive teacher training and ready-to-use educational materials, during the project lifetime more than 110 educators will be trained and over 1,200 pupils across 40 schools will be engaged, promoting STEM interest while particularly encouraging participation from underrepresented groups in the project countries. The developed curriculum framework and training materials (published as Open Educational Resources) as well as the open-source and cost-effective educational robotics platform and the novel lending system will serve as a blueprint for sustainable use in further European countries during and after the project implementation.

Acknowledgment: Co-funded by the European Union (KA220-SCH - Cooperation partnerships in school education). Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

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VITA – Vocational Innovation through Teaching with AI

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INTRODUCTION

The project aims to empower vocational (VET) teachers with the knowledge and skills needed to effectively integrate artificial intelligence (AI) into their teaching. By connecting AI with active learning methodologies, it promotes a student-centered approach that better engages the new generation of learners. Ultimately, the project seeks to prepare students for rapid technological change and ensure they are equipped to succeed in an AI-driven world, while also aligning educational practices with evolving industry needs.

Project Acronym: VITA

Project ID: 2025-1-LT01-KA220-VET-000362456

Program: Erasmus + KA220-VET - Cooperation partnerships in vocational education and training

Target group: VET teachers and VET schools, beneficiaries: VET students

Partner countries: Lithuania, Hungary, Italy, Spain Duration: 1st September 2025 - 31st August 2027

Coordinator: Alytaus Profesinio Rengimo Centras, Lithuania

The Consortium includes 6 organisations from 4 countries (4 VET schools and 1 SME and 1 association).

The project will integrate teacher training into a three-step process in which not only teachers learn, but also the school itself becomes a learning organization.

The first step is a school-wide initiation, involving collaborative learning within the school community, where not only teachers but also school leaders actively participate. The learning objective is to familiarize participants with the fundamentals of AI (including its history and key concepts) and to develop an understanding of its potential, risks, and ethical challenges in

education. This knowledge empowers school leadership, in collaboration with teachers, to enhance the school's digital strategy by incorporating AI, tailored to the school's unique characteristics and aligned with the labour market expectations of the sector of their profile.

The second step involves an extended, in-depth collaborative learning process for teachers in a blended format, covering the full range of AI solutions applicable to vocational education. This includes AI in industry, in teaching and learning, in teachers' daily tasks, and in their professional development (lifelong learning). Special emphasis will be placed on AI solutions that support Erasmus priorities and uphold European values. The curriculum will showcase how AI tools can be effectively aligned with pedagogical objectives using innovative teaching methods.

In the third step, teachers apply their newfound knowledge by designing and delivering AI-enhanced lessons or projects in their classrooms. They gather feedback from students and summarize their experiences in a pedagogical self-reflection, which is then compiled into case studies to be shared with the broader educational community.

The three-step model fosters digital readiness and capacity at both the individual and institutional levels. School leaders, teaching staff, and students all engage with AI-driven innovations, ensuring a holistic approach to digital transformation and strengthen digital resilience.

The project starts in September of 2025. In this paper we share the results of our preliminary research in 2024 aimed to get clear evidence, that there is a strong need for guiding vocational teachers to understand the basic concepts of artificial intelligence and to equip them with the knowledge and skills to effectively integrate artificial intelligence (AI) into their teaching.

VOCATIONAL TEACHERS' READINESS, ATTITUDES, AND NEEDS REGARDING THE INTEGRATION OF ARTIFICIAL INTELLIGENCE (AI)

As part of the proposal development process, the project partnership conducted an online survey to assess vocational teachers' readiness, attitudes, and needs related to the integration of Artificial Intelligence (AI) in education. The primary objective of the survey was to validate the following preliminary assumptions:

1. Vocational teachers often face uncertainty and hold misconceptions about AI.
2. Teachers acknowledge the increasing importance of AI in the labor market and recognize the need to adapt accordingly.

3. Although students are already engaging with AI technologies, many teachers feel unprepared to incorporate them into their teaching practices.

4. Educators show a willingness to adopt AI in the classroom but require targeted professional development to do so effectively.

CONCLUSION AND ACKNOWLEDGMENT

The survey sampled 269 vocational education teachers from four European countries: Hungary (29.89%), Italy (35.06%), Lithuania (12.18%), and Spain (21.77%). Most respondents were women (56.83%), with notable gender differences between countries—Spain had more male teachers (61.02%), while Lithuania had a significantly higher proportion of female teachers (69.7%).

Teaching methods

Frontal teaching remains the most used method, with 53.5% of respondents using it frequently. More modern approaches like flipped classroom techniques were less popular, indicating that vocational education is still transitioning to innovative pedagogical strategies. Inquiry-based learning and experiential learning were also utilized less frequently, reflecting potential areas for development.

AI in daily teaching tasks

When asked about the use of AI for daily teaching tasks, such as preparing lesson plans or assessing student work, most teachers expressed interest but only a small fraction were actively experimenting with AI. The reluctance to fully adopt AI tools was due to concerns about digital competence, with many teachers mistakenly believing that advanced ICT knowledge is required to use AI effectively.

Attitudes toward AI and technology

Teachers expressed both optimism and caution regarding AI's role in education. While 43% agreed that AI is essential for the labor market, over 50% believed that most teachers are not yet prepared to integrate AI into their classrooms. Furthermore, teachers stressed that effective AI integration requires managerial support and teacher collaboration.

Implementation & general figures

Survey period: 17–23 July 2024

Platform: EU Survey portal

Sample size: 269 valid responses

Countries represented: Hungary (29.89%), Italy (35.06%), Spain (21.77%), Lithuania (12.18%)

Gender distribution: 56.83% female, 42.44% male

Educational background: 68.27% held a master's degree (MSc), but only 9.96% had vocational qualifications

Teaching experience: 73% had over 11 years of experience

Institution types: Mostly vocational high schools (51.66%)

The survey results clearly justify the relevance of the project's aims, confirming that vocational teachers need targeted support to understand and apply AI in their teaching and that there is strong interest in student-centered, AI-integrated methodologies aligned with labor market demands.

More details in the document: [Secondary School Teachers' Attitudes Toward AI Integration in Teaching - Survey across four European countries](#)

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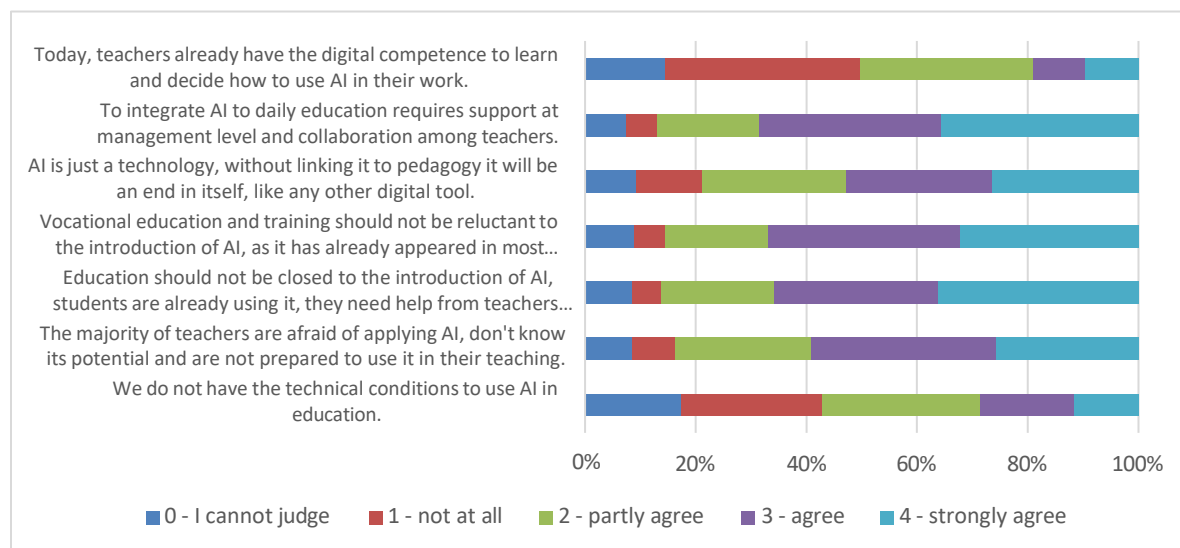


Figure 1. Teachers' agreement with statements on AI integration in education (n=269). Source: VITA Project Online Survey, 2024 (Question 8. To what extent do you agree with the following statements 0 - I cannot judge, 1 - not at all, 2 - partly agree, 3 - agree, 4 - strongly agree)

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Computational Thinking Meets Green Skills and Entrepreneurship Education

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INTRODUCTION

Digitization, production innovations, and the ongoing climate change are influencing and reshaping private and professional areas, posing challenges for both education systems and labor markets. These sectors are required to identify new skill demands while also developing and implementing effective teaching strategies. In this context, the European Commission emphasizes the need for new skills to sustain the competitiveness of EU's labor market [1]. The project Come-ThinkAgain¹ (COMputational and Entrepreneurship THINKing And Green Agenda INnovations) addresses these challenges by fostering a strategic collaboration between Higher Education (HE) and Vocational Education and Training (VET) institutions. The project develops and implements a certification based training system covering the three content pillars Computational Thinking Skills (CT), Entrepreneurship Education & Innovation Skills (EE) as well as Sustainability & Green Skills (GS). The overall project goal and approach was first presented at ICODSIP 2024 [2] and at EARLI 2025 [3]. In the project's first year, co-creation workshops across all partner countries in combination with in-depth reviews and analyses of existing frameworks and curricula resulted in a consolidated and validated list of competences and teaching methods aimed at promoting skills in CT, EE and GS. These results were presented at Constructionism 2025 [4]. This short project paper provides a project midterm update, specifically focusing on the developed pilot and validation concept. The project is co-funded by the European Union (ERASMUS-EDU-2023-PI-ALL-INNO) and comprises partners from Austria, Switzerland, Estonia, Finland, Denmark, Belgium, Spain, and Ireland.

¹ <https://comethinkagain.eu/> (last access 10/2025)

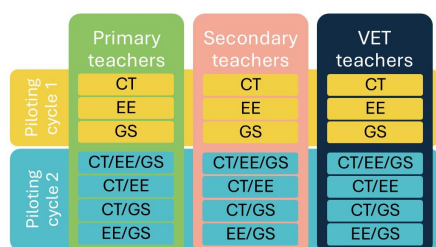
PROCESS/WORK PACKAGES

The project is organized in five work packages, including “project management & coordination”, “content design & creation”, “piloting & validation”, “implementation & deployment” as well as “dissemination & communication”. The focus of this paper is on the developed piloting and validation concept. It is based on an iterative participatory evaluation approach [5] that utilizes project stakeholders to iteratively assess and interpret the outcomes and results of piloting activities based on qualitative and quantitative data, collected during validation events and workshops. The overall project validation is structured into five phases, from pilot validation and evaluation-concept development to pilot implementation and evaluation in two iterative cycles.

MOST RELEVANT RESULTS, CONCLUSION AND ACKNOWLEDGMENT

As of September 2025, phase 1 has been completed in which the piloting and evaluation concept was developed and validated by an internal review process as well as through the external advisory board, consisting of 15 independent experts from academia, public authorities and education. In parallel, the design and development of nine learning micro-modules for the first cycle of pilot implementations for phase 1 started. Figure 1 shows the micro-modules to be implemented for piloting cycle 1 (starting in Q4 2025) and piloting cycle 2 (starting in Q2 2026) for each target group (primary, secondary and VET teachers) and each content pillar (CT, EE, GS), and their intersections respectively. Piloting cycle 1 serves to establish the foundation and test the overall concept. In cycle 2, the focus shifts to the intersectional aspects, building on the lessons learned and insights gained from the first cycle

Figure 1. Overview of micro-modules, piloting cycles and target groups



Each micro-module is piloted at least once by project partner institutions as well as external associated organisations. A cycle 1 micro-module is equivalent to 1-3 ECTS credits. For cycle 2, the content focus of micro-modules shifts to content areas at the intersections of either two or all three content pillars. All micro-modules are designed based on the previously developed **consolidated and validated list of 49 competences**². In terms of teaching methods, the design of the

² <https://comethinkagain.eu/wp-content/uploads/2025/04/D.2.1-Review.pdf> (competence list on page 77; last access 10/2025)

micro-modules is grounded in learner-centred approaches that emphasise active engagement and the integration of theory and practice. Drawing on constructionism as a guiding concept [6], we adopt methods such as project- and problem-based learning [7], design-based learning [8], making [9] and storytelling [10]. These are complemented by game-based and collaborative approaches, which have been shown to strengthen engagement and teamwork. Together, these methods foster creativity, critical thinking, and the application of knowledge in authentic contexts, thereby ensuring the meaningful development of competences across the three pillars. In the upcoming phases the project will leverage the innovative integration of Computational Thinking, Green Skills and Entrepreneurship, highlighting its significance in fostering holistic, future-oriented competencies essential for sustainable and inclusive primary, secondary and vocational education.

Acknowledgment: Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the EACEA. Neither the European Union nor the granting authority can be held responsible for them.

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CyberMe - Unleashing the Cyber Potential of Young Women

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INTRODUCTION

In today's rapidly evolving technological landscape, European societies are at the forefront of innovation, with Cybersecurity playing a crucial role. To fortify Europe's future, the EU adopted the Cybersecurity Strategy, aiming to enhance resilience against cyber threats and build a secure, digital Europe [1]. However, a significant shortage of Cybersecurity professionals hampers organizations' ability to address critical and ever rising cyber risks. Despite progress, the Cybersecurity industry has long struggled with gender disparity. Traditionally viewed as a "boys' club", it has discouraged young girls from pursuing tech careers. Societal stereotypes, lack of role models, unconscious biases, and limited opportunities contribute to this gap. Fostering interest and encouraging young women in Cybersecurity strengthens the field by closing the skills gap.

The CyberMe project aims to play a key role in these efforts by equipping young women with the skills and confidence to pursue Cybersecurity careers, going beyond gender barriers and stereotypes and helping to build an inclusive, resilient Cybersecurity ecosystem in the EU. The project will enable transnational knowledge exchange and Cybersecurity non-formal training to female youth across multiple countries through a series of youth camps, workshops and a cyber hackathon.

The project is co-funded by the European Union (Erasmus+: KA220-YOU - Cooperation partnerships in youth) and comprises organisations from Germany, Bulgaria, Cyprus, Italy, Malta and Austria.

PROCESS

The overall objective of the project is to empower young women for careers in Cybersecurity and to promote gender diversity by delivering an engaging upskilling program that sparks interest and prepares them for entry-level roles. To achieve this, CyberMe applies well-proven concepts and methods: it includes real-world, hands-on exercises based on the principles of constructionism to enhance job readiness [2]. It incorporates gamified Capture-the-Flag (CTF) challenges to build skills in a fun, competitive environment [3]. It supports youth educators with gender-inclusive teaching resources. A blended learning approach will combine online and in-person, self-paced, and collaborative activities to make Cybersecurity training accessible across various countries and learning styles [4]. Project outcomes are disseminated and further sustained through mentorship networks, while role model sharing across Europe supports a sustainable long-term impact.

MOST RELEVANT RESULTS, CONCLUSION AND ACKNOWLEDGMENT

Commencing in Q4 2025, the project remains at a very early stage at the time of writing. The project duration is two years. One of the project's innovative and most relevant results will be its Launchpad Program, which will be a pioneering non-formal Cybersecurity pathway exclusively for young women. The Launchpad Program will provide an inclusive, beginner-friendly pathway to Cybersecurity designed to attract participants who are under-represented in the field, with particular outreach to young women. It will introduce foundational concepts in accessible language and explore how cybersecurity contributes to social good and the protection of EU values.

As the first non-formal program aligned with CompTIA Security+ certification¹, it will help young women to earn industry-recognized credentials, thus enhancing their future employability.

The project will implement a series of Female Youth Camps and international youth conferences as well as Cyber hackathons and educator workshops in six countries. This is complemented by

¹ <https://www.comptia.org/en-us/certifications/security/> (last visited 03.10.2025)

a mentorship database and a series of national youth events to promote and further broaden the program.

In conclusion, the CyberMe project specifically focuses on female youth and educators, offering tailored tools, camps, and hackathons to foster gender diversity in Cybersecurity. It addresses a critical gap by empowering young women to pursue education and careers in digital security, a field still underrepresented by female talent.

Acknowledgment: Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the EACEA. Neither the European Union nor the granting authority can be held responsible for them.

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General Digital Fitness of Employees: Applying the DigCompSAT in Companies

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INTRODUCTION

The digital transformation is fundamentally changing the world of work. It's altering how products are developed, manufactured, and marketed. It's also changing how companies are organized and how customers and businesses interact. This transformation in practically all areas of the workplace continuously alters the competence requirements for employees. Estimates suggest that around 90% of jobs require some level of digital competence [1].

For companies, employees who don't have the necessary general digital competences can quickly become a problem. This is not only because these employees can no longer be integrated into processes in a rapidly changing work environment, but also because they can hinder efficient (digital) collaboration in teams and generally slow down the company's digital transformation. To be as well-positioned as possible for the advancing digital transformation, companies must ensure they not only have enough specialists with specialized digital competences in certain functions but also that all employees have the best possible general digital competences.

As part of a pilot project, a bidt industry partner – a German mechanical engineering company with more than 1,000 employees at various locations worldwide – used a short version of the DigCompSAT [2] the DigCompSAT-mini [3] as part of a larger evaluation of the company's digital transformation. The goal was to quantitatively assess the general digital competences of employees in order to derive development potential.

METHOD

The used short version of the DigCompSAT [2] the DigCompSAT-mini [3] consists of just 21 selected, particularly meaningful statements from the full 82 statements. These items are particularly effective at explaining the index derived from all the items [3, 4]. The data for the adapted short form of the DigCompSAT also used in the bidt-Digitalbarometer surveys [4] was collected through a voluntary, anonymized quantitative online survey of employees from different business units of the industry partner in Europe (Oct. 7-25, 2024, n = 175), in China (Nov. 25-Dec. 12, 2024, n = 83), and in India (Feb. 11-28, 2025, n = 111).

FINDINGS

The results show that the employees of the mechanical engineering company from Germany who participated in the survey have similar digital competences as general employees in the vehicle and mechanical engineering and automotive repair and trade sectors in Germany, with an average of 68 points on the index running from 0 to 100 points. Employees of the company in the other European countries achieved a slightly higher score at 70 points on average. For participating employees in China (66 points) and India (67 points), the average scores were slightly below the value determined for Germany. Employees with responsibility for other employees scored slightly higher on digital competences at 69 points on average than employees without responsibility for personnel (67 points). By company tenure, new employees showed slightly higher digital competences than employees with longer tenure. Larger differences in digital competences emerged by functional area. Employees in marketing / communications achieved the highest competence score, while employees in the commercial area achieved the lowest. (See figure 1)

CONCLUSION

The pilot project on the use of DigCompSAT in companies shows how the short version DigCompSAT-mini of the self-assessment test can provide a preliminary assessment of the distribution of general digital competences among employees in companies. This provides a crucial first overview of the general digital fitness of employees for the digital transformation. The advantages are the simple, efficient, and quick application possibility without the need for adaptation to specific roles or functions of employees, as well as the immediate external comparability due to its foundation in the European DigComp framework. Limitations exist due to the relatively abstract, global results without a concrete reference to the individual requirements of the company for specific roles or functions. Therefore, the test should only be a starting point for all employees, to then build upon it with a more detailed and needs-oriented assessments of the digital competences of employees in individual functional areas.

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*Figure 1. Index scores (0 – 100 points): Short version of DigCompSAT: DigCompSAT-mini
(Source: [5] and data collected by the bidt industry partner)*

bidt-Digitalbarometer 2025 [5] (representative German data)



bidt industry partner in the mechanical engineering field

