



Learner Centric Advanced Manufacturing Platform



Skills Assessment Toolkit (LCAMP 4.0 Deliverable D5.2)

WP5 Learner Centric Training

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GLOSSARY AND/OR ACRONYMS

AIComp - Artificial Intelligence Competency Framework
AR - Augmented Reality
CF - Competency Framework
CLF - Collaborative Learning Factory
CoVE - Centres of Vocational Excellence
CPS - Cyber Physical Systems
DigComp - The Digital Competence Framework for Citizens (2.2)
ELM - European Learning Model
EQF - European Qualifications Framework
ESCO - European Skills Competences and Occupations
EntreComp - The Entrepreneurship Competence Framework
EXAM4.0 - Excellence Advanced Manufacturing 4.0
GDPR - The General Data Protection Regulation
GreenComp - The European sustainability competence framework
HVET - Higher Vocational Education and Training
I4.0 - Industry 4.0
IOT - Internet of Things
LCT - Learner-Centric Training (WP5)
LifeComp - European Framework for Personal, Social and Learning to Key Competences
LLM - Large Language Model (ChatGPT)
LO - Learning Opportunity
VET - Vocational Education and Training
WP - Work Package



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EXECUTIVE SUMMARY

This D5.2 report provides a comprehensive overview of the educational and technological concept and tasks executed to deliver the Self-Assessment Toolkit (D5.2) as the first integrated learning toolkit working on LCAMP. This document presents and reflects the work method and results achieved to deliver an easy-to-use reflective assessment toolkit for Workers and Learners in Advanced Manufacturing. Last but not least, this deliverable lays the foundation for subsequent development of LCAMP's innovative learning approach. The tasks carried out follow the clear target to cater to the needs of a digital, open and sustainable learning environment fostering lifelong learning in advanced manufacturing across Europe and beyond.

The newly developed **Self-Assessment Toolkit working on LCAMP** (D5.2) represents a significant milestone in LCAMP's Learner-Centric Platform (LCT) approach and can be considered the first visible tool fostering innovative learning in line with the multi-stage Learning & Development process in LCAMP.

The toolkit's main goal is to enable learners and workers in advanced manufacturing to actively engage in a of their job-related skills sets and experiences directly on the platform. The users' individually acquired competencies and working experiences, referring to job-specific knowledge, skills, attitudes and some behavioural aspects, can be assessed against those competencies that the LCAMP consortium considers future-proof for thriving in sector-specific working environments.

The Assessment toolkit therefore is conceived to be human-centric on multiple levels, both holistic and sector-specific: It is holistic concerning learners' heterogenic educational background and occupation-specific by referring to the most demanded technology trends and related Future Skills in I4.0 workplace, researched and defined by the LCAMP Observatory's reports and sub-reports (WP3).

With that in mind, the **LCAMP Competency Framework (LCAMPComp)** represents the crucial conceptional frame and can be considered LCAMP's flexible educational backbone for LCAMP's up- and reskilling model. It is conceived to ensure future users to thrive in fast changing digitalized and technology driven working environments. The Framework was researched and designed to answer the twin transitions challenges and fosters sustainable training solutions to enhance both human and systemic resilience across manufacturing workplaces. LCAMPComp will align education and training approaches delivered, offered and created over the project's lifetime. The Framework comprises therefore both classical and forward-looking competency areas researched and validated by the consortium as "future-proof" to thrive in fast-changing, digital, and sustainable manufacturing workplaces of the 21st century.

To ensure interoperability and well harmonized educational approaches among cross-sectoral educational initiatives (co-funded by the EU) in this field, LCAMPComp explicitly incorporates specific results, already delivered by research initiatives such as DigComp (Vuorikari et al., 2022), GreenComp (Bianchi, G.et al., 2022), EntreComp (Bacigalupo et al., 2016), and IAComp (Ehlers et al., 2023) to cover a holistic approach and understanding of transversal

Competencies. Consequently, principles are sought to empower users to successfully communicate, cooperate and collaborate in fast changing digitalized, globalized and increasingly intercultural intertwined learning and working environments.

The self-assessment toolkit's concept seeks to react to this reality equally following the above-mentioned premisses. The toolkit ensures interoperability not only with internal platform tools — developed over the next two years — but also with preceding external digital infrastructures such as the European Learning Model (ELM) the ESCO database and [the European Approach to micro-credentialing for lifelong learning and employability](#).

These foundational requirements for Europe-wide interoperability contribute to subsequent digital toolkits such as the skills and course matching tool, an occupation creator, a course database offering sector-specific learning opportunities, finally linked under the umbrella of a comprehensive Learning Pathway Tool.

This report outlines crucial methodological steps, tasks and outcomes of the work carried out in the Learner-Centric-Training alias Work Package 5 (LCT/WP5), associated with the most relevant technological aspects considered and implemented by Work Package 8 (WP8, D8.2 Advanced Manufacturing Excellence Discovery Platform, version 2).

The result of this co-development is a sector-specific Self-Assessment Toolkit for lifelong learning working across European H-VET systems and beyond (Deliverable, D5.2). All tasks and results presented in the following chapters have been carried out with support of WP5 or WP8 team members. LCAMP's partner Institutions equally contributed and validated the outcomes of this endeavour.

The following overview on tasks performed within WP5 mark crucial development phases on the way to deliver the milestones (MS10/11) required for populating the digital deliverable (D5.2) collaboratively developed as a metacognitive Self-Assessment Toolkit in Work Package 8 (WP8).

- a) Why develop a self-reflective toolkit for assessing the users' job-related knowledge, skills, and attitudes?
- b) Literature review and comparative analysis of suitable Competence Frameworks and Best Practices for up-and re-skilling the workforce in Industry 4.0.
- c) Development of a sector-specific Competency Framework for Learners and Workers in Advanced Manufacturing focusing on job-specific competencies and co-factors for enhancing human and systemic resilience to master the twin transitions' challenges.
- d) Conversion and mapping strategy for harmonization of the consortiums' Curricula into an ESCO-compatible 'Skills Language'.
- e) Delivery of more than 1200 Skills datasets retrieved and harmonized across the LCAMP consortium's VET curricula, systematically mapped with both the ESCO (V1.2) database and LCAMP Competency Framework.
- f) Co-creation and validation of newly developed human-centric self-assessment statements mapped to the LCAMP framework's Sub-Categories (KSA) to populate the assessment toolkit embedded in LCAMP.
- g) Populating LCAMP's sector-specific course catalogue with over 5000 courses, mapping both partners up-skilling courses and internationally relevant learning opportunities (LO) scraped and implemented into the platform's course database.



1. INTRODUCTION

1.1. WHY A REFLECTIVE ASSESSMENT

This introduction underpins the decision in LCAMP to implement a self-assessment tool on the LCAMP platform to foster reflective learning practices and self-regulation among learners and workers before engaging in a more complex and objective assessment method for assessing a learner's maturity and prior learning achievements.

The literature on skills assessment for workers and learners in Industry 4.0 (I4.0) environments underscores the critical importance of empowering learners with self-assessment tools as an initial step towards more sophisticated learning and skills-matching approaches. Recent research and the work carried out in Skills and Trends Observatory in Work Package 3 (WP3), highlight the rapid evolution of job roles and competencies in the I4.0 landscape, necessitating agile methods for skills evaluation and development (Prifti et al., 2017). This supports the decision to prioritize the development of a self-assessment toolkit, which can adapt to the dynamic nature of technology trends in I4.0 and changing skills requirements.

In addition, numerous studies emphasize the role of self-assessment in enhancing learners' autonomy and metacognitive skills, which are essential for success in complex and evolving work environments in I4.0. By engaging learners in the process of assessing first their own competencies, newly developed toolkit aligns with research-supported principles of learner-centric education as advocated by León, S.P., Panadero, E. & García-Martínez, I. (2023).

Furthermore, the most recent work of Aldosari et al. (2023) demonstrates the effectiveness of self-assessment tools in promoting reflective learning practices, facilitating goal setting, and fostering self-regulation skills among learners. These findings provide compelling support for the decision as a transnational working group among WP5 colleagues, composed of VET teachers and educational researchers, to develop a learner-centric assessment toolkit as the foundational component of a broader learning and skills-matching approach within the platform infrastructure.

In conclusion, the literature review within the LCT supports the significance of developing a self-assessment toolkit as the initial step toward the expectations for a more comprehensive approach to learning and skills development delivered on the platform's I4.0 learning environment. Drawing on the above-cited research findings, the toolkit is positioned as a foremost strategic human-centric investment in learner empowerment making the learners proactively engage in their metacognitive development and adaptability to fast-evolving skills requirements in the advanced manufacturing sector.



1.2. THE SKILLS ASSESSMENT TOOLKIT ON THE PLATFORM

1.2.1. IMPLEMENTATION PLAN / USER JOURNEY

The self-assessment tool allows the user to assess their skill proficiency for the following skill and competence categories defined in the LCAMP framework:

1. Professional
2. AI Literacy
3. Digital
4. Green
5. Traversal

SKILL SELF-ASSESSMENT TOOL



Select a skill category you would like to assess.

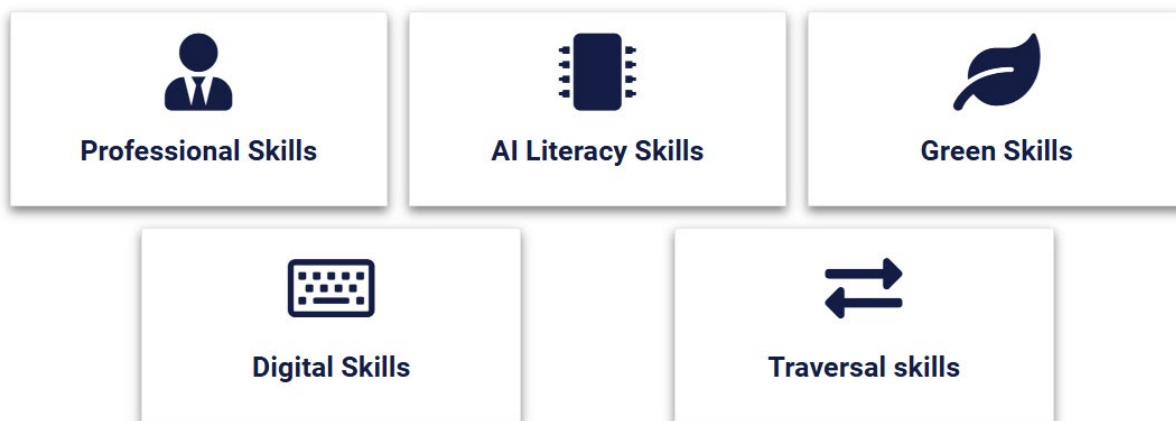


Figure 1. Skill self-assessment tool

For the breakdown of each skill category please refer to Table 1.



1.2.2. USER JOURNEY

The user registers to the LCAMP platform to access the self-assessment tool.

The user completes a self-assessment of a skill by rating statements on the 5-point Likert scale adjusted from 0 – “Strongly disagree” to 4 – “Strongly agree”. By completing the assessment, the user is presented with an average score based on their answers rounded to the nearest full number. The score corresponds to the proficiency levels defined in the LCAMP Skills Framework:

- 0 – No proficiency
- 1 – Beginner,
- 2 – Intermediate,
- 3 – Advanced,
- 4 – Expert

After completing an assessment, the user score is recorded in the Skill Profile. The user is then prompted to complete an assessment for another skill. The user can also review their submitted assessments under the Completed Skills List tab.

1.2.3. FUTURE INTEROPERABILITY AMONG TOOLS

The self-assessment tool is part of the larger Skill Profiler toolkit. The user's profile will later be connected to the Job Call Builder and Course Catalogue via the Skill Matching Tool, which will present users with job and course recommendations based on their Skill Profile.



2. EDUCATIONAL R&D IN D5.2

2.1. LEARNER-CENTRIC CONCEPT

2.1.1. OPERATIONALIZATION OF THE COMPETENCY CONCEPT

As referred to in numerous research disciplines such as Psychology, Education, and Organizational Development, the concept of Competency has been researched and defined in many different ways, and considered a ‘fuzzy’ concept in its nature, still is the subject of ongoing research.

The objective of this definitional introduction is to decompose and operationalize the complex construct of competency for the platform development digital learning approaches and to break it down into its essential elements, which can be assessed, taught and trained individually via the learning technologies at hand.

For this reason and to make the following explanations and methodological approaches easier to understand, this report outlines a common understanding and wording for providing an easy-to-grasp working definition for both the development team and the reader of this report. The common understanding is built on the fundamentals of the definitions that have been established by Prifti et al. (2017). The authors explicitly researched up- and reskilling needs in the advanced manufacturing sector and defined competencies as:

“[...] behaviours that are instrumental in the delivery of desired results or outcomes”. With this in mind, “a competency is not the [desired] behaviour or performance itself but the repertoire of capabilities, activities, processes, and responses available that enable a range of work demands to be met more effectively by some people than by others”. (Prifti et al., 2017, p. 48)

Following Prifti’s previous definitions, the LCAMP Learner-Centric-Training working group understands and defines the terminology frequently used in the context of learning in Industry 4.0 (I4.0) as follows:

Competency:

A competency is defined as a set of behaviours essential for achieving desired outcomes or impacts. It includes knowledge, skills, activities, processes and reactions that enable individuals to effectively fulfil specific work requirements. Competencies are not the behaviours themselves, but represent the individual repertoire of knowledge, skills, and attitudes available to the individual in a given situation. A competency, and this is important to keep in mind when conceiving a skills assessment, “does not attempt to describe a level of performance” (O.V., 2019, p. 4).

Skills:

Skills are outlined as the practical abilities required to perform specific tasks effectively. They are acquired through work experience, life experience, formal or informal study or training. Skills are essential components of competencies and contribute to an individual's ability to achieve the desired results required by a specific workplace. (Prifti et al. 2017, p.48)



Knowledge:

Knowledge refers to the understanding or awareness of facts, information, concepts, or principles relevant to a particular area or task. It is an integral part of competencies and skills and forms the basis for performing tasks and making informed decisions in I4.0 environments. (Prifti et al. 2017, p. 48)

Attitude:

Although not explicitly defined by Prifti, attitudes in I4.0 workplaces refer to an individual's mindset or disposition towards their work, colleagues, and technological advancements. Positive attitudes such as adaptability, openness to change and willingness to learn are crucial for success in dynamic environments (Prifti et al., 2017, p.48).

The above summarized 3-level granularity and operationalization of the concept of competency, for taking action in specific working environments, was chosen and conceptionally followed to ensure the best possible consistency and interoperability with already developed EU competency frameworks such as DigComp, EntreComp, GreenComp and AIComp which use the same terminologies and conceptional principles.

2.1.2. MOST DEMANDED SKILLS FOSTERING HUMAN AND SYSTEMIC RESILIENCE IN ADVANCED MANUFACTURING

Which specific skills does the European workforce in advanced manufacturing need to master the increasingly complex opportunities and challenges in state-of-the-art I4.0 workplaces?

To identify the most demanded Skills in advanced manufacturing workplaces, the European, Turkish and Canadian H-VET Institutions, constituting the transnational working group in LCAMP WP5, have undertaken several approaches and tasks. The first outcomes of this research reflected in the LCAMP Competency Framework built on the methodological foundations and tasks carried out as follows:

- Literature review of the most recent reports, addressing up- and reskilling needs in the advanced manufacturing sector.
- Continuous cooperation and regular workshops with associated industry-clusters to foster knowledge transfer for I4.0 up- and reskilling needs, such as CECIMO.eu and partner industry clusters (AFM, AFIL, MADE, MV, Dual Industry Partners of DHBW).
- Continuing monitoring and re-evaluating of LCAMP partner institutions' I4.0 curricula regarding future- proof learning opportunities in line with industry needs.
- Desk-research on future-proof I4.0 specific competencies (October 2023).
- Screening and mapping of partners' curricula to identify and validate future-proof I4.0 skills datasets (November 2023).
- Comparative Analysis of suitable I4.0 Frameworks performed by LCAMP WP5 partner institutions.
- Weekly sprint meetings to collaboratively monitor, discuss, peer-review and validate LCAMP.



2.2. I4.0 FRAMEWORK FOR HUMAN-CENTRIC UP - AND RESKILLING

2.2.1. SOCIO-ECONOMIC & TECHNOLOGICAL CHANGES STRESSING THE NEED FOR A 'LIVING' FRAMEWORK IN LCAMP

The advent of Industry 4.0 (I4.0) and the global need for a sustainable and more resilient economy has revolutionized manufacturing and other industrial sectors by integrating digital technologies such as automation, IoT, CPS, AI, and advanced data analytics. This transformation necessitates a comprehensive rethinking of workforce skills, with a strong focus on upskilling and reskilling to meet new job demands.

Competency frameworks (CF) serve as essential tools in this context, providing structured guidance for aligning education and training to up- and reskill the workforce with industry requirements. More explicitly defined a competency model is a formalized tool that helps in identifying, evaluating, and cultivating the necessary skills, knowledge, and behaviours for proficient performance in a specific job, role, or sector. It offers an organized frame and method to pinpoint essential competencies needed for success and ensures these are in alignment with the strategic goals and objectives of an organization or sector (Prifti et al., 2017, p. 49). Last but not least, it aims to provide clear expectations for both learners, teachers and trainers, ensuring that training programs are aligned with the needs of the industry. The specific goals for a new 'living' and interoperable Competency Framework for LCAMP in the context of I4.0 in are to:

1. Constantly identify the pivotal skills and knowledge areas required for cutting-edge green manufacturing environments increasingly influenced by automation and AI applications.
2. Facilitate the development of targeted training programs that prepare workers for current and future job roles.
3. Enhance the employability and adaptability of the workforce in line with a rapidly changing technological, societal, demographical manufacturing landscape in Europe and beyond.

This section delves into the meticulous development process of the competency framework within the LCAMP project. This endeavour is rooted in a profound understanding of the dynamic landscape of advanced manufacturing, particularly in the context of Industry 4.0. Central to this approach is the recognition that the skills demanded by this ever-evolving sector must not only meet current requirements but also anticipate future socio-economic and environmental needs.

The genesis of the framework lies in a comprehensive analysis conducted within WP5, where a meticulous mapping of advanced manufacturing skills deemed "future-proof" by the consortium. By identifying competencies marked as obsolete or outdated, initial insights into existing skills gaps among the consortium curricula. To systematically address these gaps in alignment with emerging trends.

Moreover, the imperative of continual refinement and adaptation in response to shifting skill requirements is recognized, especially considering the consortium's preceding research approaches (Rupp et al., LD3, 2021). The EXAM4.0 methodology provides the foundations for the further framework development in LCAMP. In LCAMP a forecasting approach within the LCAMP Observatory (WP3) has been leveraged to precisely pinpoint upskilling signals. This intelligence is expected to serve as the foundation for the iterative evolution of the framework



domains over the next two years, ensuring their perpetual alignment with industry demands, technology trends, and changing up- and reskilling needs, stressed and appreciated by regional manufacturing industry partners.

Crucially, the insights gleaned from the Observatory inform the development and composition of the LCAMP Course Catalogue (D5.3), wherein scraped and newly crafted short courses and Micro-Credentials are tailored to facilitate lifelong learning among LCAMP stakeholders and future users. These offerings, seamlessly integrated into the adaptable design and digital infrastructure of the LCAMP framework, epitomize the commitment to fostering a workforce equipped to thrive in the dynamic landscape of advanced manufacturing.

Developing such a highly adaptable learning model embedded in the platform's digital infrastructure, tailored to the specific needs of I4.0 environments across Europe and beyond, can be considered a never-ending journey that is both critical and vital to ensure that VET programs remain relevant and effective by constantly adapting to societal, environmental, technological and demographic change across the globe. By incorporating Items from existing frameworks and successful EU Initiatives, focusing on both technical and soft skills helps better prepare the workforce for the challenges of modern manufacturing.

With the aim of designing a both flexible and reliable future-proof framework for innovative learner-centric continuing education and training in LCAMP, a multi-stage design approach to develop LCAMPComp was used.

On the one hand, the methodology is based on [canonical development schemes](#) (O.V.,2019) used in competence framework development in cooperation with transnational industry clusters and educational institutions, on the other hand, the consortium draws on its transnational expertise and specific surveys sent to local industry networks.

Aligned with LCAMP's overarching strategy of harmonization and internationalization, the endeavour is to ensure that the learning approach remains not only adaptable but also interoperable with educational research programs and policies published by the EU Council. Thus, it was imperative to consider the conceptual foundations of prior EU and institutional initiatives during the desk research. This approach enabled the identification of transversal competency areas, ensuring optimal interoperability of the conceptual and digital project results.

This premise not only is pivotal for the construction and operationalization of the concept of competency according to Knowledge, Skills and Attitudes (KSA) favoured by the [EU Council Recommendation](#), but mirrors also the structural block-building approach regarding transversal competency areas, already researched and defined within [LifeComp](#) (Sala et al., 2020) [GreenComp](#) (Bianchi, Pisiotis, & Cabrera Giraldez, 2022), [EntreComp](#) (Bacigalupo et al, 2016) and [DigComp](#) (Vuorikari R. K., 2022) as [AIComp](#) (Ehlers et al., (2023)). With this more transversal educational umbrella in mind, the Framework intentionally incorporates a holistic European up-skilling concept for sector specific education and training. The focus is on fostering eligible Key Competencies essential for thriving in modern European workplaces and societies. Considering the target groups, it is understood that not all preceding framework items have been included. Instead, careful selection, identification, validation and incorporation of those competency domains against the premises relevant for lifelong learning in I4.0 have been carried out.



The schematic model of LCAMP's competency framework presented and described hereafter is implemented in the digital infrastructure on the platform. This sketch and "Block-Building" overview cannot adequately represent the underlying datasets and development processes and interrelationships of selected Competency domains. The following explanations intend to serve as a plausibility check and show the objectives, premises, and methodological considerations on which it was based and were culminating in the categorization approaches.

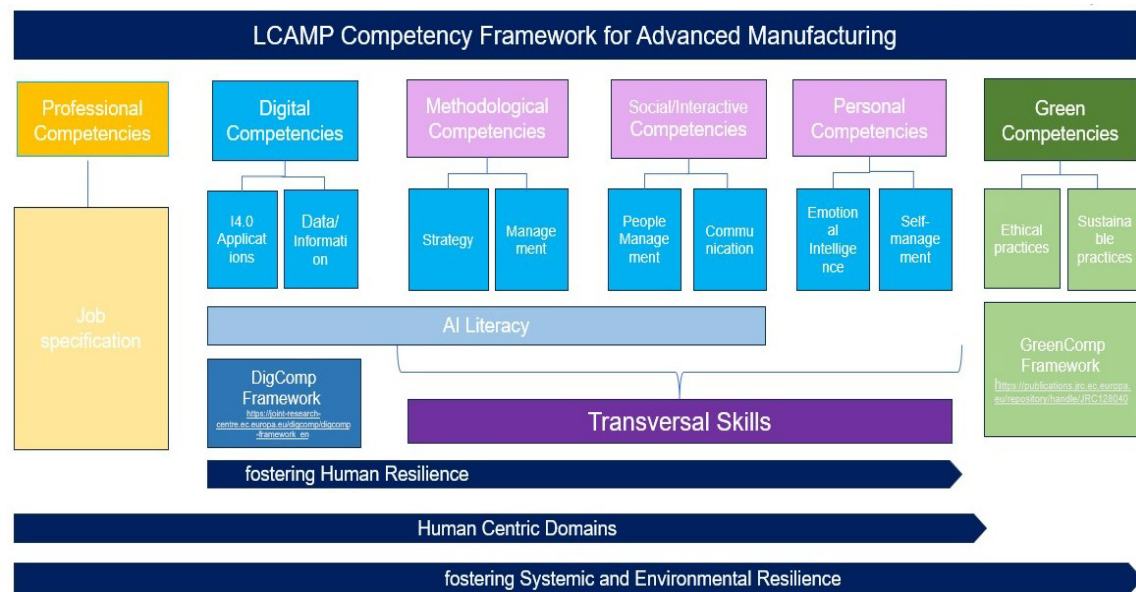


Figure 2. LCAMP Competency Framework (V.1)

Here is an overview of the development phases and premises applied, outlining systematically the tasks executed in the LCT (WP5) for defining both the framework's structure and its Competency domains:

2.2.2.FRAMEWORK DESIGN AND JOB-RELATED COMPETENCY IDENTIFICATION

Structuring the identified competencies into a coherent framework, often categorized by determining overarching domains and sub-domains, represents one of the most pivotal phases in designing a learning model and framework (Palacios & García, 2022, p. 115).

To undertake this foundational methodological step, which entails providing an adequate frame and categorization of competency areas, the transnational development team in WP5 opted for a comparative analysis of prominent competency frameworks developed for up-skilling and reskilling in I4.0 Workplaces. This comparative analysis approach focused on recent reports serving as "role models." One of the main challenges and crucial questions involved analysing and incorporating new relevant domains necessitated by disruptive technological advancements such as AI and environmental imperatives, aligning with both learner and industry needs in accordance with the EU's Sustainable Development Goals (SDGs).

The crux of the matter in this domain lies in the contentious decision-making processes and the subsequent challenges faced. At the heart of this issue is the inquiry into the extent to which



job- and workplace-relevant skills, both presently and potentially in the future, are essential for the job profiles pertinent to LCAMP in Advanced Manufacturing I4.0. This critical inquiry demands immediate attention, as it forms the cornerstone of the framework, ensuring that education and training profiles evolve synchronously with the digital and green transformation processes.

To effectively address and continually update this “future skills” database of “Professional Competencies” within the framework, primary dependence is placed on insights validated by experts from VET education, industry and policy makers within the trends and skills observatory in WP3. The observatory furnishes annual signals regarding the ongoing evolution of the twin transitions — both in terms of the economy and the corresponding shifts in workplace dynamics and skill requirements. These insights inform the adjustments necessary within the education and training framework (CF), as developed herein in WP5, to meet the current demands of the labor market. The resultant European policy recommendations stem from this collaborative effort (WP2).

2.2.3. SKILL NEEDS ANALYSIS— APPLICATION CONTEXTS FOR VET IN ADVANCED MANUFACTURING

Advanced manufacturing, which integrates technologies such as the IoT, Programmable Logic Controllers (PLC), robotics, and Augmented Reality (AR), creates a variety of new application contexts. These highly connected and automated production environments demand new skills and competencies from learners and workers. The key implications for VET reached in the comparative analysis of I4.0 Frameworks and after a critical screening and mapping of curricular Skills and Competencies include:

1. **Technological Competency:** Employees must acquire in-depth knowledge of the latest technologies. This includes operating and maintaining IoT devices, programming PLC systems, integrating and operating robotic solutions, and using AR for maintenance and training.
2. **Data Competency:** Given the increasing availability of data, workers need to be able to collect, analyse, and use data in real-time to optimize decision-making processes and monitor production operations.
3. **Methodological Competencies:** New strategies and management skills are required to effectively control complex systems. This nowadays also includes the ability to implement sustainable practices.
4. **Social/Interactive Competencies:** Collaboration in interdisciplinary and transnational teams is becoming more important. Communication and team management are crucial skills for developing and implementing innovative solutions.
5. **Personal Competencies:** Emotional intelligence and self-management are considered important for remaining resilient in a constantly changing work environment.



2.2.4. NEW COMPETENCIES REQUIRED BY THE USE OF ARTIFICIAL INTELLIGENCE IN INDUSTRY 4.0

A recent study on AI competencies by Ehlers et al. (2023) highlights that the increasing development and use of AI in Industry 4.0 requires new skills and competencies from workers and learners. The data gathered in German workplaces, using a mixed-method approach, provides evidence that AI technologies fundamentally change the way production processes are controlled and optimized.

It clearly shows that AI is fundamentally changing the world of work. The competency requirements are shifting towards a stronger focus on technological skills, data competency, but also ethical considerations. Ehlers et al. (2023) emphasize the need to promote AI Literacy as a central competency to successfully meet the challenges and opportunities of Industry 4.0 and highlight that continuous learning and adaptability are crucial for successfully managing the ongoing automation and digitization in manufacturing.

The global understanding of the fast-proliferating AI applications, according to Ehlers et al. (2023), implies that the most required upskilling needs include first and foremost:

1. **AI Literacy:** A Basic understanding and skills in handling AI technologies are essential: This includes knowledge of how AI, especially LLMs works, the application of AI tools, and the interpretation of AI-generated data.
2. **Ethics and Responsibility:** With the introduction of AI in production, workers must understand the ethical implications and act responsibly.
3. **Data Management and Analysis:** The ability to manage and analyse large amounts of data is increasingly important for making AI-driven decisions.
4. **Innovation Ability:** Flexibility and creativity are needed to develop and implement new AI applications.
5. **Continuous Learning:** Due to the rapid development of AI technologies, continuous training and adaptation to new tools and methods are necessary.

2.2.5. CONCEPTUAL POSITIONING OF AI LITERACY IN THE LCAMP COMPETENCY FRAMEWORK

Based on the results of the study by Ehlers et al. (2023) AI Literacy can be identified as a new central, transversal “future-proof” competency that permeates several both job-specific and canonical transversal competency areas. The graphical positioning and allocation of the competency domain “AI” Literacy and could be as follows:

- **AI Literacy is a Central Competency:** This should be positioned directly under the digital competencies, as it is key in handling I4.0 applications and data/information.
- **Integrated into the methodological and Social/Interactive Competency Block** to foster the strategic use of AI and to enhance communication and collaboration in the context of AI.
- **Connected to Personal and Green Competencies:** The ability to use AI ethically and sustainably should be reflected in these competency areas.



2.2.6. STRATEGIC CONSEQUENCES AND UP-SKILLING NEEDS REGARDING AI APPLICATIONS

In line with these findings, at least for the time being, AI Literacy is understood as a transversal “future skill” that first and foremost is increasingly required by all learners and workers to interact and thrive in highly complex digitalized and interconnected professional environments. Given the fact that, after successful screenings, flagging, and mapping of the VET Curricula for future-proof Advanced Manufacturing Skills, multiple Skills Gaps regarding AI Literacy were discovered among LCAMP’s transnational VET curricula. As a consequence, the LCT intended to address these skills gaps with immediate effect, creating Assessments-Statements to evaluate the users’ AI Literacy referring to a transversal Future Skills as researched by Ehlers et al. (2023).

Since AI Competencies are expected to be increasingly important and intertwined with ‘traditional’ work- and life-related Skills sets, LCAMP WP3 and WP5 will constantly reassess the evolution of new emerging Skills Gaps across the sector to ensure the validity of both LCAMPComp and the associated assessment datasets.

2.2.7. STAKEHOLDER CONSULTATION

In all CF development phases LCAMP national partner institutions were reaching out to engage with industry experts, educational researchers, deans of faculties, and teachers and trainers across local industry networks and associated clusters to gather valuable insights and validate the frameworks competency domains. This approach represents a steady-state phase in further development process to ensure and validate the Frameworks’ yearly updates.

2.2.8. VALIDATION AND REVIEW OF THE LCAMP FRAMEWORK’S CONCEPT

Piloting and validating the framework’s concept with transnational sample groups is crucial for the reliability of the represented core competency domains. The Framework has been iteratively improved and multilaterally validated within the LCT Working Group and industry Stakeholder Networks at national and regional levels. Necessary adjustments based on industry partners’ feedback have been considered in the design phase. Last but not least, the integration of feedback from the transatlantic partner, Camosun College in Canada, is appreciated. Since Canada joined the consortium at a later development stage, the important reassessment provided, enhancing a more refined way to represent “Professional Competences” in LCAMP in line with the Canadian provincial strategy for Up- and Reskilling for I4.0 will be considered and implemented in the next updated version of LCAMPComp.

The Annex provides a schematic overview of the current Competency Framework’s conceptional foundations: Representing the framework’s High-Level Competency Areas and its more specific Subcategories are shown in Figure 3. Both the Skills-mapping and the Harmonization Approach with ESCO and transnational curricular Skills is provided and described in the following chapters. Curricular job-related Skills and newly created assessment statements are currently allocated and performed at the Subcategory Level.



2.3. MAPPING LCAMP INSTITUTIONS' 14.0 SKILLS TO THE LCAMP FRAMEWORK AND THE ESCO DATABASE

2.3.1. OBJECTIVE OF THE SKILLS-MAPPING CARRIED OUT

The overall goal in WP5 is the internationalization and digitalization of sector-specific higher vocational education and training. This aligns with the EU's Centres of Vocational Excellence (CovEs) initiative's strategic objective, which aims to make national vocational education centres more agile, cooperative, and resilient to provide up- and reskilling opportunities for lifelong learning in VET to master the green and digital transformation and be more resilient when facing unpredictable disruptive events (such as climate change, energy crises, wars, and supply chain disruptions). The approach outlined here for harmonizing sector-specific curricula and learning data represents a significant milestone, marking an initial success within LCAMP. These efforts towards intra-European harmonization and digitalization are still in their early stages, closely linked to the hope to contribute further to the development of the [European Learning Model \(ELM\)](#), relying on the premise that the ELM will support the efforts with policies and guidelines for and digital European learning infrastructure.

The main goal of this task was to map and harmonize LCAMP partner institutions' transnational H-VET curricula regarding Advanced Manufacturing qualifications to both the Framework's Competency domains and related [ESCO \(V1.2\)](#) Skills. This approach aimed to bridge heterogenic competency descriptors across national partner institutions and sector-specific learning opportunities, such as qualification-related modules, short courses, and micro-credentials for up- and reskilling. Additionally, this task tackled the challenge of providing a harmonized categorization and classification of transnationally provided curricular skills in line with the LCAMP framework's learning approach.

Moreover, another crucial objective was to establish a working conversion model enabling the consortium to bridge competency-based descriptors by allocating related ESCO skills to the curricular skills' estimated maturity levels per institution. The complex and challenging endeavour to map the maturity level of each skill provided by the transnational curricula aimed to enable differentiated levelling between the same skill provided at different EQF levels by different institutions and heterogeneous education systems and various learning environments. This classification of maturity levels, estimated and validated by international learning experts, can only provide hints regarding their precision.



2.3.2.THE ROLE OF ESCO IN THE LCT APPROACH

The European Multilingual Classification of Skills, Competences, and Occupations (ESCO) plays a pivotal role in the European Union's labour market by providing a comprehensive database that outlines and categorizes essential knowledge, skills, competencies, and occupational profiles.

The Learner-Centric Training in LCAMP leverages the extensive ESCO databases to bring consistency to educational and training opportunities across Europe. Access to ESCO's detailed information on occupational skills, knowledge, and competencies enhances transparency and supports the facilitation of job and learning mobility throughout the EU. Aligning LCAMP's learning approach closely with ESCO not only aids in enhancing the interoperability of the LCAMP platform with other European initiatives like EUROPASS and ELM but also aligns with their shared vision of harmonizing education and training for the future of learning in Europe.

WP5's efforts are directed towards outlining learning outcomes, forward-looking competencies, qualifications, and courses, and linking them to the relevant ESCO skills. This involves a critical step of syncing the terminology, descriptions, and concepts used within ESCO with those used by the LCAMP consortium's national curricula and competency frameworks, ensuring alignment with European harmonization standards.

The approach ensures that the terminologies and descriptions used in the learning model are in harmony with those in the ESCO database. As a result, each competency category within the LCAMP Framework corresponds to an existing entry in ESCO, whenever available. This alignment process considers all ESCO pillars and involves significant effort in WP5 to integrate, update, and map terminologies between ESCO and the insights from the Observatory (WP3) alongside national curricula, contributing to LCAMP's dynamic learning model.

Moreover, LCAMP WP5 envisages a mechanism to enrich ESCO by identifying and incorporating new competency terms and skills not currently listed but emerging within occupational profiles, qualifications, and courses. This feedback loop not only enriches the ESCO database but also ensures that it remains a current and comprehensive resource for the European labour market.

2.3.3. EXPECTED OUTCOME AND OBJECTIVE

The comprehensive mapping of national I4.0 competencies through independent analysis and evaluation of relevant qualifications and curricula forms the data basis for processing learning data on the platform's learning offerings. The expected outcomes are:

- LCAMP consortium's curricular learning offerings in the EQF 3-6 range relevant to advanced manufacturing are systematically recorded, mapped, and linked to the competency framework and the ESCO database, and classified for machine readability.
- The mapped learning datasets on the platform meet the milestone requirements, enabling the consortium to present and process more than 1000 harmonized learning datasets on the platform infrastructure.



2.3.4.METHODOLOGICAL APPROACH

To achieve goals of a unified consortium-wide skills dataset (learning data), the project leaders from the L&D department at DHBW and the platform developer KIC developed a mapping template in several platform design workshops. This template allowed for the necessary categorization and classification efforts in line with the LCAMP competency model and the ESCO Skills database. After testing and validating the mapping template for functionality and piloting it through the partner institutions in WP5 Sprint Meetings, the template was issued to the partners for skills mapping. To achieve MS 10 (LCAMP skills assessment toolkit creation) and the indicators in the Grant Agreement (I30 = 1000 Skills profiles performed and I31 = degree of satisfaction of AM VET/HVET students and SME workers measured by means of an evaluation questionnaire 80%), LCAMP partner institutions were tasked with analysing their national I4.0 curricula in the targeted EQF range (3-6) for I.40 relevant skills.

The harmonization template used, designed to map over 1000 skills and learning datasets across partner institutions, was conceived to map skills from all types of learning opportunities (LO) across the consortium (courses, trainings, modules) as part of a qualification with the competency framework in LCAMP as uniformly as possible. The mapping method aimed to depict all relevant items that appeared pertinent to the internationalization and digitalization efforts for curricular and extracurricular learning offerings with ESCO. The following categories and items were recorded and formally captured as follows:

- Skill label/title
- Description of the skill or competency
- Allocation to the LCAMP Framework: Competence Area (high-level Category)
- Subcategory within the LCAMP Framework
- AI Literacy (YES/NO curricular embedded skill regarding AI application areas)
- EQF-Level of the mapped skill
- Reference to the national providing VET institution where the specific skill is imparted and accredited
- Mapping of each curriculum skill to the skills provided by the ESCO database
- Four-stage maturity level of the mapped skill relative to the reference area of training and courses offered in LCAMP (EQF 3-6 at L1: Beginner; L2: Intermediate; L3: Advanced; L4: Expert).

To meet the target and Indicators (I30), each of the LCAMP Institutions provided in average 150 curricular skills datasets and mapped them using the skills-mapping template. The template appeared as a suitable frame to implement a functional classification and linkage method.



2.3.5.TASK DESCRIPTION

The mapping started by identifying future-proof advanced manufacturing skills provided by LCAMP VET institutions. Partners identified relevant skills from national advanced manufacturing study programs (curricula) per institution and country. The national skills were mapped using the Skills-Mapping Template for harmonization needs, including the items listed here above. The ESCO matching approach involved using the newly developed LCAMP Skill Finder application by KIC to enhance the time-consuming matching processes individually performed by LCAMP institutions to the ESCO database.

All LCAMP institutions populated the LCAMPComp with more specific skills data from national curricula/courses. Each institution was instructed to provide 150+ datasets to meet the indicator, ensuring an equal distribution of the workload among partners.

Finally, the LCT Working group in WP5¹ held sprint meetings every second week for peer review and validation of the datasets provided to ensure consistency in terminology and accurate execution of the matching procedures.

2.3.6. DATA GATHERING AND MITIGATION STRATEGY

Some partner institutions were challenged to meet the number of skills datasets required due to their size and less comprehensive curricula regarding future-proof skills in advanced manufacturing. Fortunately, the consortium was able to compensate for these bottlenecks through cooperative efforts.

The results of this initial harmonization strategy for cross-national Skills-Datasets are not explicitly listed in Excel format in this document; instead, they are visible as an integral outcome within the LCAMP platform, the working self-assessment toolkit and its digital infrastructure. This methodological approach allows for continuous optimization and adaptation of the original dataset to changing needs in subsequent versions of the toolkit, supporting the agile approach in platform development. Additionally, this method enables the incorporation of feedback from further testing into the original skills dataset, which will be integrated into the current beta version after initial internal and external testing procedures. For the competency framework, which must also adapt to rapidly changing training needs, the same presentation format is consistently applied in this report, referring to a schematic overview model of the competency framework for reasons of representational economy.

¹ LCT Working group in WP5 consists of educational researchers from Camosun College (Canada), DHBW (Germany), MADE Competence Centre 4.0 (Italy), CMQEf (France), Skupnost VSS & TSCMB Maribor (Slovenia), TKNKA, Miguel Altuna (Basque Country), GEBKIM VET (Turkey), and Curt Nicolin College (Sweden).



2.4. LEARNER-CENTRIC STATEMENTS FOR LCAMP SELF-ASSESSMENT TOOLKIT

The following sections will provide the detailed methodology, specific tasks executed, and the results achieved, highlighting the collaborative efforts and challenges to co-create specific Learner-Centric Assessment-Statements for the new LCAMP Self-Assessment Toolkit. This part delves more specifically into the tasks undertaken.

On one hand, LCAMP partner institutions' H-VET curricular descriptors provided the educational foundations to be converted into learner-centric assessment statements for job-specific Skills. On the other hand, the representing and assessing relevant Skills that have been defined, described, classified and partly mapped within DigComp, EntreComp, GreenComp, and AIComp.

Using a metacognitive assessment toolkit, learners and workers on the platform are invited to explore lifelong learning opportunities by first assessing their educational horizon in a more ludic approach fostering their metacognitive skills and awareness of what they consider themselves capable.

2.4.1. OBJECTIVE AND RATIONAL OF THE SPECIFIC TASK

The objective of this task in D5.2 was to craft learner-centric statements for populating the LCAMP self-assessment toolkit with the requisite datasets. A key challenge was to devise a method that comprehensively evaluates and represents the competency areas of the LCAMP Framework through tailored self-assessment statements.

Adhering to initial premises on operationalizing the Competency Concept, it became apparent that each competency domain needed to be represented holistically delineated into three levels of granularity: Knowledge, Skills, and Attitudes as initially defined. This necessitated populating the framework's 44 subcategory domains (Figure 2) with a set of well-designed self-assessment statements.

The datasets generated aimed to empower learners and workers in advanced manufacturing to gauge their maturity level using the consortium-validated educational framework. Balancing comprehensiveness with time efficiency posed a further challenge. Given LCAMP's sector-specific focus, the decision favoured a job-related assessment emphasizing technical skills over a comprehensive soft skills evaluation.

To maintain both time feasibility and holistic coverage of Skills, Knowledge, and Attitudes (SKA), the transdisciplinary development team determined that a minimum of six assessment statements must be created for each of the 44 subcategories. Additionally, to granularly test competencies across levels (KSA) on a Likert (0-4) scale, two statements were required for each of SKA.

In pursuit of a more detailed strategy for assessing job-related skills, the development team decided to double the assessment statements for job-specific categories, resulting in finally allocating 12 statements, adhering to the same conceptual principles.



It is evident that a sector-specific assessment, mapping new and specific skills comprehensively, offers greater value and appeal compared to a generic soft skills assessment. Consequently, an intricate metacognitive and sector-specific assessment toolkit stands as a valuable asset, fostering user empowerment and facilitating future success in the manufacturing industry for LCAMP's target groups.

2.4.2. METHODOLOGICAL APPROACH AND RATIONAL FOR PROVIDING THE ASSESSMENT DATA

To collect the relevant data according to the considerations and guidelines outlined above, a template was designed in LCT to segment and manage the various work steps, and to subsequently review and validate the quality and fit of the produced datasets. All statements were iteratively reviewed professionally and linguistically in several cycles after completion. LCT partners reviewed their respective areas of responsibility and validated the competence areas through peer review with other partners to ensure a high-quality dataset.

The following describes and details the execution of the individual work steps and their distribution among the consortium partners.

A template was created to generate, adapt, and assign the corresponding statements according to the subcategories of LCAMPComp (Figure 2).

LCAMP partner institutions were responsible for developing statements based on the 0-4 level Likert- Scale (Joshi et al., 2015), respecting the framework's specifications and established criteria, using the cited competency models' inherent granular descriptors. To ensure harmonization, the following structurally relevant syntactic and semantic design rules were strictly followed.

- The wording of the statements was meant to be learner-centric according to the project credo.
- Meant to reflect the corresponding granular competency concept following the canonic terminology of Knowledge Skills and Attitude addressed and linked at the framework's subcategory levels.

Consequently, the following learner-centric phrases and operators emerged:

- *Knowledge:* "I know/I'm aware of..."
- *Skill:* "I can..."
- *Attitude:* "I care about..."

To meet these requirements, the assessment statements needed to refer to various maturity levels according to Bloom's Taxonomy (Seaman, M., 2011). The partners were tasked with selecting and aligning the professional content of each statement to ensure that two statements in a cohort assessed different maturity levels: the first representing a low-level maturity and the second a relatively higher maturity. This approach was duplicated for the job-specific competency domains and statements, resulting in pairs for each maturity level (2x low, 2x medium, 2x high).

A joint task force within the LCT WP was established to create occupation-specific assessment statements related to job-related competencies represented by LCAMPComp. This was particularly necessary because, apart from the I4.0 curricula available among the consortium



and the sector-specific VET competencies anchored therein, there was hardly any data available to derive corresponding statements. It will be an ongoing endeavor in the LCT to constantly refine those assessment cohorts addressing newly researched future skills and new manufacturing technologies.

To design such occupation-specific assessment statements representing the Competency domain "Professional", "Curriculum Rewriter" initiatives were launched at some institutions (e.g., at DHBW). This gradually helps address this complex and time-consuming endeavour of rewriting occupation-specific curricula with the help of AI (LLM) so that traditional competency-based curricula (module and course descriptions) are available in a ready-to-use skill-based format, compatible with ESCO linkage. Such curricular features are highly desirable for issuing and exchanging micro-credentials among the consortium soon.

The assessment statements currently available have been validated by the LCAMP consortium and were then migrated to the platform. To make this document easier to read, we have refrained from presenting the extensive data sets for the skills assessment and skills mapping directly in this document.

Instead, we have included the data in a separate annex attached to this report.



3. IMPLEMENTATION AND REALIZATION OF THE SELF-ASSESSMENT TOOLKIT

3.1. TECHNOLOGICAL ASPECTS

The LCAMP Self-Assessment tool is the first component of a series of tools on the LCAMP platform, that allows the user to assess their Professional, Digital, Green, Traversal, and AI literacy skills. By assessing skill statements on a scale from 0 to 4 the user fills in their skill profile and receives an average score for each skill rounded to the nearest full number (1 – Beginner, 2 – Intermediate, 3 – Advanced, 4 – Expert). The score is recorded in the user's skill profile. The user's skill profile will later be connected to other tools like the Job Call Builder and Course Catalogue via the Skill Matching Tool, which will present users with job and course recommendations.

3.1.1. TECHNICAL IMPLEMENTATION & INTEROPERABILITY

The self-assessment tool is currently set up as a standalone tool on the LCAMP website. The tool consists of a series of sub-pages connected by a common header section, where the user can:

1. access and edit their profile,
2. complete self-assessments and
3. review their completed assessments.

The tool is set up in the WordPress content management system (CMS), like the rest of the LCAMP website. User profiles and user submissions are stored on the WordPress backend, which is hosted on the Kinsta,2024 hosting service. All the data is safely stored and can only be accessed with authorised admin access. Data is collected only when provided willingly by a user and by the General Data Protection Regulation (GDPR) privacy policy.

3.1.2. USER TESTING

The self-assessment questions and skill categories were validated by the WP5 partners and implemented on the platform by WP8. To make sure the tool is functional and easy to use WP8 carried out the first round of user testing internally and externally to ensure 80% success rate. The user testing was conducted online as a self-administered user test, where test users consisting of SME workers and students had to complete a set of tasks related to the user journey described in section 1.2.2:

1. Sign in
2. Complete a self-assessment
3. Review your assessments



After completing the tasks, the test user was asked to submit a feedback form. In the feedback form the user marked completion of individual tasks as either successful or unsuccessful. The user was also asked to provide comments and suggestions regarding each individual task.

From the user feedback, there were no major complaints about the functionality and navigation of the tool, with each task having more than 90% completion success rate. There were several user comments and suggestions regarding the content of the self-assessment questions. All suggestions will be taken into consideration as we continue to improve the tool before connecting it to the Skill Matching Tool.

3.1.3. WALKTHROUGH

Follow this link to experience a walkthrough of the Skills Assessment Tool:
<https://app.tango.us/app/workflow/LCAMP-User-Skills-Assessment-81debf976bb0476fb640ad73634321fd>

3.1.4. ACCESS TO THE TOOLKIT

The tool can be accessed here: <https://lcamp.eu/skill-self-assessment-page/>



4. COURSE DATABASE

The course database is another component of the LCAMP platform, that will be connected to the LCAMPComp Framework via the Skills Matching tool. WP8 prepared the first version of the database as a browsable Course Catalogue on the WordPress website.

The course database currently consists of more than 500 upskilling and reskilling learning opportunities centered on industry 4.0, with 75 sector-specific courses at EQF level 3-6 provided by the partners in line with MS11. The rest of the courses were scraped from EdX, 2024.

The scraping was done with the help of Selenium, 2024 automated web browsing suite. Using automated web browsing, we were able to browse the entire EdX course database by topic, selecting relevant topics related to Industry 4.0. Using a custom Python script, we were able to scrape relevant course data page by page. All the course data was then harmonised with the parameters of the European Learning Model and then migrated to the Course Catalogue.

As more courses are scraped using the scraping tool, they will be imported to the Course Catalogue. The partners are also able to add additional courses via the WordPress front end.

The Course Catalogue can be accessed here: <https://lcamp.eu/course-catalogue/>



5. CONCLUSION AND OUTLOOKS

The LCAMP platform's Skills-Assessment Toolkit is an innovative tool designed to help users evaluate their proficiency in key competency areas including Professional, AI Literacy, Digital, Green, and Traversal competencies. The self-assessment tool not only provides immediate feedback on skill levels but also creates a dynamic profile that connects with other platform features like the Job Call Builder and Course Catalogue. This integrated approach ensures that users receive tailored job and course recommendations, fostering continuous personal and professional growth.

5.1.1. TECHNICAL OUTLOOK

The technical output aims to continue building on the following pillars:

Enhanced Interoperability: Future developments will focus on deepening the integration among various tools on the platform. By M24-48, users will experience seamless interoperability, allowing for more personalised and accurate skill matching to both job and education-related career opportunities.

User-Centric Improvements: Continuous user testing and feedback incorporation will remain a priority. The feedback from initial testing has shown high satisfaction rates, but ongoing adjustments based on user suggestions will ensure the tool evolves to meet users' needs effectively.

Expanded Course Offerings: The Course Catalogue, already populated with over 500 courses, will continue to grow and include micro-credentials and courses provided and issued by the LCAMP Partners, ensuring the database remains comprehensive and up-to-date with industry trends.

Data Security and Privacy: The platform will maintain strict adherence to the GDPR policies, ensuring that all user data is securely stored and managed. This commitment to data privacy will help build and maintain user trust.

Technological Advancements: As technology evolves, the platform will incorporate new features and improvements to enhance user experience. The integration of advanced AI and machine learning algorithms could provide even more personalised and accurate recommendations for users.

Community and Collaboration: The platform will foster a community of learners and professionals, encouraging collaboration and knowledge sharing. This community aspect will be crucial for users looking to network and learn from their peers.

In summary, the LCAMP platform is being developed to become a comprehensive resource for skill development, offering users not just tools for assessment, but also pathways for growth and opportunities for advancement in their careers within Industry 4.0. Continuous innovation and user-focused improvements will ensure the platform remains relevant and valuable in an ever-changing labour market.



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9. ANNEXE: SUBCATEGORIES OF LCAMPCOMP

Table 1. Subcategory Items of the main Competency Areas Assessment Statements and Skills mapping is allocated to those Subcategories

DIGITAL	GREEN	PROFESSIONAL	TRANSVERSAL	AI LITERACY
Data Management	Supporting fairness	Handling Production Principles	Critical thinking	Initiative/ Implementation
Cybersecurity	Collective action	Competencies in STEM	Problem-Solving	System Design
Data safety & security	Individual initiative	Manufacturing	Analysing	Creativity/Problem Solving
Digital ethics	Valuing sustainability	Additive Manufacturing	Creativity/Innovation	Critical Digital Competence
Data Literacy	Promoting nature	Simulation	Planning & Organising	Decision Making
ICT	Follow environmentally-sustainable work practices	Safety	Result-oriented	Efficacy
Programming/ coding	Use sustainable materials and components	Scientific work	Willingness to Learn/Continuous Learning	Critical Thinking
Computer Skills		Electrical engineering	Flexibility/Agility	Active Management
Big Data		Soldering / welding techniques	Customer-oriented	Autonomy
		Human-machine-interactions	Self-management	Ethics
			Decision Making	
			Responsibility	
			Communication	
			Cooperation/Teamwork	
			Diversity	
			Empathy	





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