Make My Future

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Competence Framework

Industry 4.0 profiles for Vocational Education and Training

2022

MakeMyFuture - Improving Digital Competences for Advanced Manufacturing Industries through Maker Education

R1 - **MakeMyFuture Competence Framework**
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Introduction

This Competence Framework is a product of the project MakeMyFuture, an Erasmus+ KA2 Cooperation Partnership project in Vocational Education and Training, co-funded by the European Commission. The project aims at supporting VET teachers in implementing maker-based activities for providing VET students with advanced digital competences, in line with the changes of the Industry 4.0.

The document provides a reference of 8 profiles required by industry 4.0 in partner countries (Italy, Spain, Germany, Malta, Poland). They are described in terms of knowledge, skills and competences using a common language, based on the learning outcomes approach that can be understood across Europe.

The learning outcomes identified are aligned to the standard VET curricula of the partner countries, so to be easily integrated into the VET schools practices.

This document is designed to support VET schools and teachers to continue up-skilling VET students with the competences required by Industry 4.0, connecting the VET sector to the latest developments of labour market. The main aim is to support VET education to react to the Covid-19 crisis, preventing high unemployment rate of young people in partner countries and workforce shortcomings for the Industry 4.0 sector.

Industry 4.0 technologies are considered by the European Union as horizontal technologies “enabling” multiple sectors that are expected to be decisive in tomorrow’s economy (EC, 2019 Curriculum Guidelines for Key Enabling Technologies and Advanced Manufacturing Technologies). Despite the great potential of these technologies in supporting youth employment, there is a lack of appropriate and multidisciplinary curricula providing the related digital skills. This is identified as a key barrier also to the development of innovation and digital transformation (EC 2020 Youth Employment Support: a bridge to jobs for the next generation).

In this document, in addition to the detailed description of the profiles, you can find also a description of the methodology implemented by the MakeMyFuture partnership. This will enable other organisations and countries to do the same process and adapt the Competence Framework to their contexts and interests.

Methodology

This document has been produced by the MakeMyFuture partnership based on a process involving different stakeholders.

Phase 1

During the first phase, the partnership, through a desk analysis, analysed curricula and training programs at national level in order to select the most relevant competences needed by Industry 4.0. The partners selected and analysed 35 curricula or programmes in the different partner countries.
The courses, training programmes and curricula have been analysed in terms of learning outcomes highlighting knowledge, skills and competences achievable.

The elaboration of these data resulted in a list of 178 learning outcomes divided in 15 main competence areas:

Industry 4.0

1. Additive Manufacturing
2. CNC
3. CAD/CAM
4. Automation
5. Cloud Computing
6. Cybersecurity in Industry 4.0
7. Data Analysis, AI and Machine Learning
8. Drones and AGVs
9. Intellectual Property and New Technologies
10. IoT
11. Local, Remote and Predictive Maintenance
12. Networks and Industrial Communication Technology
13. Rapid Prototyping and Reverse Engineering
14. Robotic technologies
15. VR and AR

During the second phase, the partners identified the most important learning outcomes required by Industry 4.0 in partner countries. This task was carried out through an online questionnaire involving industries and experts in industry 4.0. Respondents were asked to grade the learning outcomes (knowledge, skills and competences) on a scale between 1 (not important) to 5 (very important) considering the EQF levels 4 and 5. In total 76 questionnaires were collected in all the partner countries.

Phase 2

Phase 3

At this point, the average value of the responses in each country was calculated and were considered as important for that country only the learning outcomes with a score above the average.

Then those elements considered important by, at least, 3 out of 5 countries have been selected s.

Finally, the learning outcomes (knowledge, skills and competences) selected have been aligned with the VET curricula in partner countries and translated by the MakeMyFuture partnership into profiles needed by Industry 4.0.

The following 8 profiles have been selected:

- Additive Manufacturing technician
- CNC operations technician
- CAD/CAM Designer
- IT Communication technician for Industry 4.0
- Data Analyst for Industry 4.0
- IoT technician for Industry 4.0
- Robot machines technician for Industry 4.0
- Automation technician for Industry 4.0

Profiles

P1. Additive Manufacturing technician

Competence

C1. Ensures a smooth and reliable basic operation of 3D printing machines, setting up, maintaining and repairing additive manufacturing and 3-D printing equipment.

Knowledge

- K1.1 To describe what additive manufacturing is and how the different systems work
- K1.2 To recognise the advantages, opportunities and benefits of the different systems of Additive Manufacturing
- K1.3 To describe the sequence of process steps
- K1.4 To describe how to prepare and manage the files for printing
- K1.5 To describe the quality standards and indicators of the additive manufacturing products
- K1.6 To describe maintenance indicators and diagnostic techniques
- K1.7 to understand the more appropriate printing material, for the specific 3D printer, with respect to the object to be printed

Skills

- S1.1 To prepare and manage the files for printing
- S1.2 To properly prepare and set up at least 1 additive manufacturing system
- S1.3 To properly operate basic tasks using at least 1 additive manufacturing system
- S1.4 To check and ensure the quality of the products

P2. CNC operations technician

Competence

C2. Operates basic tasks using a Computer numerically controlled (CNC) machine

Knowledge

- K2.1 To describe what a CNC machine is and how it works
- K2.2 To describe the work cycle and steps to operate a CNC machine
- K2.3 To describe the quality standards and indicators for CNC operations and products

Skills

- S2.1 To interpret the technical-mechanical drawing in CAD
- S2.2 To properly set up a CNC machine
- S2.3 To properly operate basic tasks on a CNC machine
- S2.4 To check and ensure the quality of the products

P3. CAD/CAM Designer

Competence

C3. Creates basic 2D and 3D Models for CAD/CAM production systems

Knowledge

- K3.1 To recognise and understand different files and data types and their use
- K3.2 To present the different techniques and tools for creating a basic 3D Model for CAD/CAM systems
- K3.3 to describe the main steps for creating a basic 3D Model for CAD/CAM systems

Skills

- S3.1 To nterpret the technical-mechanical drawing in CAD
- S3.2 To properly set up a CNC machine
- S3.3 To properly operate basic tasks on a CNC machine
- S3.4 To check and ensure the quality of the products

P4. IT Communication technician for Industry 4.0

Competence

C4. Resolves faults and issues in basic communications systems for Industry 4.0

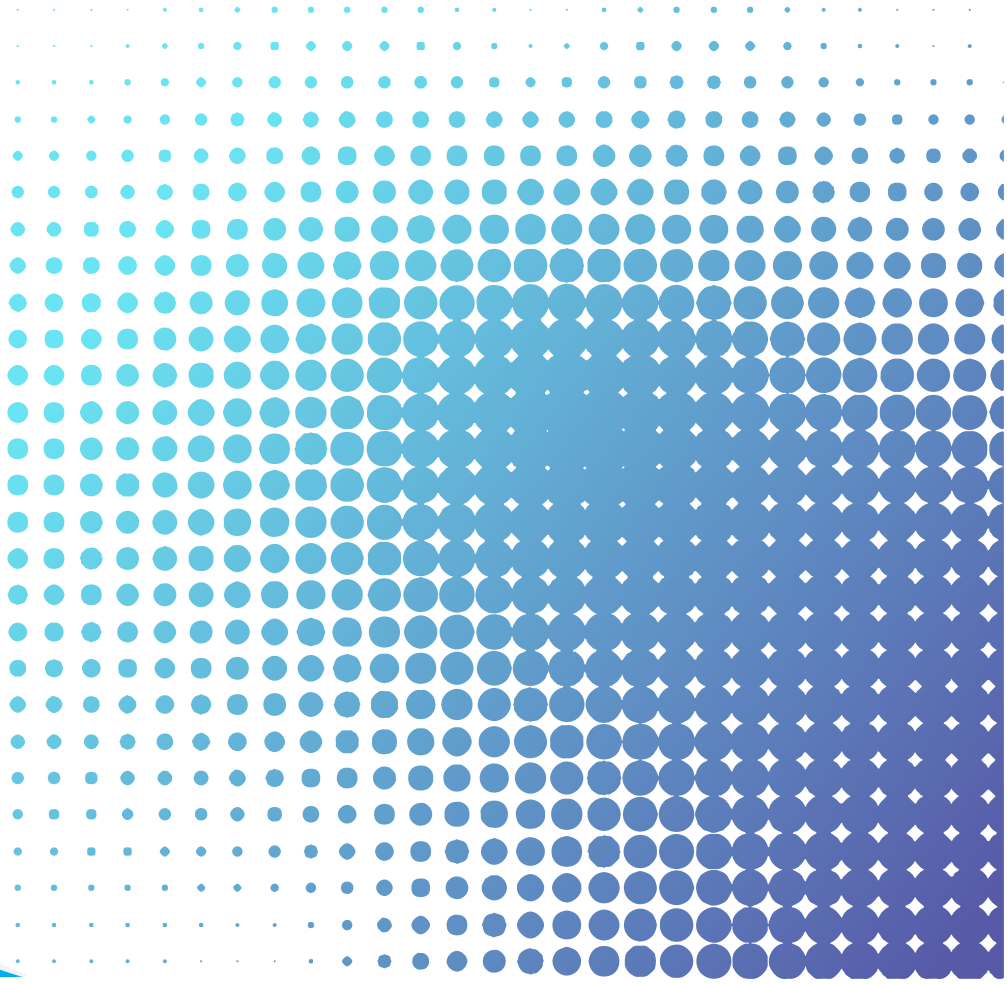
Knowledge

- K4.1 To classify the main cloud services and for Industry 4.0 and their characteristics
- K4.2 To describe the benefits of cloud computing for Industry 4.0
- K4.3 To describe virtualization and resource sharing
- K4.4 To describe how mobile-accessible data and applications work
- K4.5 To understand the risks of adopting a cloud system and how to mitigate them
- K4.6 To present fundamentals of cyber security for industry 4.0 (security requirements for devices, risk assessment, Attack surfaces and modes of penetration, Threats and consequences - the possible scenarios, Defence against attacks, The phases (Kill-Chain) of a cyberattack)
- K4.7 To list security requirements for devices
- K4.8 To describe control system architectures
- K4.9 To describe automation system architectures
- K4.10 Social engineering techniques (phishing, impersonation, dumpster driving, etc.)
- K4.11 To understand the basics of data security and cyber security (standards, protocols, certifications, protection systems for internet-based-manufacturing)
- K4.12 To describe local networks (wired and wireless)
- K4.13 To list network diagnostic tools
- K4.14 To describe how industrial bus systems/protocols (ASi, Profibus, Profinet, CAN) work.
- K4.15 To describe procedures for authorization and authentication
- K4.16 To describe maintenance indicators and diagnostic techniques

P4. IT Communication technician for Industry 4.0

Skills

- S4.1 To identify the needed cloud service type (IaaS, PaaS, SaaS)
- S4.2 To properly use cloud services
- S4.3 To create and manage a connection to a data cloud
- S4.4 To identify network components (switch, router, PLC)
- S4.5 To integrate of Security and Safety in the industrial environment
- S4.6 To guarantee information security of the company and the other employees in cyberspace
- S4.7 To improve the protection of privacy (company, customer and supplier data



P5. Data Analyst for Industry 4.0

Competence

C5. Gathers and scrutinises data and uses them for improving company performances.

Knowledge

- K5.1 To present the fundamentals of data analytics and artificial intelligence in Industry 4.0
- K5.2 To present the definition of big data how they can be used in industry 4.0
- K5.3 To describe Machine learning basics and how it can be used in industry 4.0
- K5.4 To understand how to integrate different data storage
- K5.5 To present the types of learning data and differences between learning and testing data;
- K5.6 To describe principles, advantages and techniques of predictive maintenance

Skills

- S5.1 To apply basic tools and methodologies for data aggregation, analysis and utilization
- S5.2 To apply basic tools and methodologies for predictive data analysis
- S5.3 To apply basic tools and methodologies for data analysis for predictive maintenance

P6. IoT technician for Industry 4.0

Competence

C6. Plans and implements basic IoT solutions for Industry 4.0.

Knowledge

- K6.1 To define internet of things
- K6.2 To describe IoT Technologies and applications in industry 4.0
- K6.3 To describe machine-to-machine, machine-to-person, person-to-person connections
- K6.4 To present the role of IoT and AI data analytics for intelligent decision making
- K6.5 To describe communication concepts (MQTT, PubSub, WebSockets, QoS)

Skills

- S6.1 To properly use and integrate IoT sensors
- S6.2 To plan and prepare a basic IoT solution for industry 4.0

P7. Robot machines technician for Industry 4.0

Competence

C7. Makes the setup, operation, and maintenance of a robotic machine for industry 4.0

Knowledge

- K7.1 To describe robot components, characteristics and applications.
- K7.2 To present what advanced and collaborative robots are and how they work
- K7.3 To list Advantages and disadvantages of collaborative robotics
- K7.4 To list types of collaborative robots (collaborative, Anthropomorphic Systems, Cobots, etc....)
- K7.5 To present differences between collaborative robots and industrial robots
- K7.6 To describe maintenance indicators and diagnostic techniques

Skills

- S7.1 To be able to program a robotic arm to do basic tasks.
- S7.2 To setup and monitor an industrial robotic arm.
- S7.3To be able to detect risks and safety problems while a robot is running
- S7.4 To do basic maintenance operations

P8. Automation technician for Industry 4.0

Competence

C8. Creates, repairs and maintains basic automated systems for industry 4.0

Knowledge

- K8.1 To understand how automated machines and plants work in industry 4.0
- K8.2 To understand fundamentals of mechatronics
- K8.3 To understand fundamentals of automation and robotics
- K8.4 To be aware of fundamentals of electrical engineering and electronics
- K8.5 To describe maintenance indicators and diagnostic techniques
- K8.6 To present the Potential uses of virtual and augmented reality for maintenance operations of automated systems

Skills

- S8.1 To monitor the smooth operation of automated production systems
- S8.2 To perform basic repairs on automated production systems
- S8.3 To do basic maintenance operations
- S8.4 To install basic automated production systems

Conclusions

Along with the other MakeMyFuture results, the Competence Framework has been designed for VET schools, teachers, VET institutions and any other organisation interested in supporting the acquisition of competences in line with the requests of the Industry 4.0.

While the other project results intend to give you some resources for implementing maker-based activities in VET schools, this first project result gives you an overview of the profiles and learning outcomes to be taken into consideration for the achievement of competences in line with the industry 4.0.

The profiles are relevant in all the partner countries and can be changed based on the needs of specific countries or organisations.

The MakeMyFuture Competence Framework can improve the educational offer of VET schools aligning their curricula to the changes of the Industry 4.0. The learning outcomes highlighted by the framework will help VET students to improve their employability and keep pace with the digital changes needed by the advanced manufacturing industry.

The framework provides VET teachers with a tool to produce effective educational paths and assessment methodologies for improving digital competences for VET students. The common competence framework can be easily transferred in other sectors or countries. It can also be used by Policy maker and even Industries 4.0 to train a workforce in line with the latest development of industrial technologies.