Digital Transformation in Advanced Manufacturing

DTAM Curriculum

DTAM

DIGITAL TRANSFORMATION IN ADVANCED MANUFACTURING

Co-funded by the Erasmus+ Programme of the European Union

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Co-funded by the Erasmus+ Programme of the European Union

Deliverable factsheet

Project number:	621496-EPP-1-2020-1-ES-EPPKA2-SSA
Project acronym:	DTAM
Project Title:	Digital Transformation in Advanced Manufacturing
Work package:	WP2: DTAM Training Methodology and Curriculum
Title of Deliverable:	R2.2: DTAM Curriculum (1st version)
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1 Introduction

This deliverable describes the curriculum of the DTAM project. The aim of the DTAM curriculum is to provide technicians of advanced manufacturing with the competences needed, in terms of knowledge and skills, for the transition to the fourth industrial revolution (IoT Industry 4.0). Thus, the DTAM curriculum aims to be a reference curriculum for quality training and certification in digital transformation competence for Smart Industry.

Note, that this is the first version of the DTAM curriculum. The final version of the curriculum will be produced in M30 taking into account the main findings derived by the pilots.

1.1 Structure of the deliverable

The structure of the deliverable is the following:

- Section 1 is the introduction of the deliverable that describes each scope and structure, the target audience and the dependencies with other WPs and deliverables of the DTAM project.
- Section 2 describes the methodology that has been adopted for the development of the curriculum.
- Section 3 provides the description of the curriculum, i.e. the description of each training module.
- Finally, Section 4 provides the references used to conduct this deliverable.

1.2 Target audience

The target audience of this deliverable are:

- Technicians of advanced manufacturing as the “end-users” of the curriculum.
- Education and training providers both at vocational level, i.e. VET providers and higher level, i.e. HEIs, which are interested to update their offerings with new training programs at the domain of advanced manufacturing.
- Enterprises that are operating in the manufacturing sector and want to upskill/reskill their technicians.
- Research institutions that are working at the domain of education and training.
- Policy makers at the domain of education and/or manufacturing.

1.3 Dependencies with other WPs and deliverables

This deliverable is directly connected with the deliverable “R2.1: Digital Transformation Skills Index” of WP2, as it has used the competences of the digital transformation skills index to identify the knowledge and skills of the separate training module. Moreover, it has dependencies with the following deliverables:

- “R2.3: DTAM Training Methodology” of WP2: this deliverable will offer VET staff and organizations delivering the DTAM curriculum in future IVET and CVET courses with both theoretical and practical guidelines.

- "R2.4: DTAM Teacher/Trainer Manual" of WP2: this deliverable will provide an integral guide to the DTAM curriculum for H/VET staff who will deliver the training as part of formal accredited training in IVET and CVET courses.

2 Curriculum development

This section describes the methodology followed for the development of the DTAM curriculum. More specific:

- Section 2.1 describes the key characteristics of the DTAM curriculum
- Section 2.2 describes the key terms used in the curriculum
- Section 2.3 describes the process adopted for the development of the curriculum

2.1 Key characteristics of the DTAM curriculum

The main documents that have been used as reference for the development of the DTAM curriculum are the following:

- The "Digital Transformation Skills Index" developed by the DTAM project. This index has been used as a base for the definition of the knowledge and skills of each separate training module of the curriculum.
- The CEDEFOP report for defining, writing and applying learning outcomes [1]. This report provides guidelines for effectively defining, writing and applying learning outcomes at VET.
- The EC Curriculum guidelines for Key Enabling Technologies (KETs) and Advanced Manufacturing Technologies (AMT) report [2]. This report provides a new curriculum framework for AM.

The DTAM Curriculum has been developed following a student-centered approach. Its main characteristics are the following:

- Multi-disciplinary: The curriculum provides the learners with technical competences at digital technologies for AM (e.g. big data, artificial intelligence, Internet of Things), as well as competences covering non-technical non-technical/transversal areas (e.g. leadership, communication, project management).
- Modular: The curriculum includes a set of training modules. Each module is further divided into learning units. This permits the learners to build their own learning pathways based on their needs.
- Innovative: The curriculum promotes problem (challenge)-driven learning, collaborative (collective) learning, technology-enabled learning, as well as experience-based learning.

2.2 Key terms used in the curriculum

The key terms used in the DTAM curriculum are the following:

- Learning outcomes
- Competence
- Knowledge
- Skill
- Leaning units

2.2.1 Learning outcomes

Learning outcomes are statements of what a learner knows, understands and is able to do on completion of a learning process, defined in terms of knowledge [3], skills [4] and competences [5]. Education and training institutions are increasingly describing their qualifications [6] in terms of learning outcomes following the approach adopted by EQF.

Learning outcome descriptions form part of the metadata of qualifications in ESCO. Member States or awarding bodies include information on learning outcomes when providing data on qualifications for the ESCO qualifications pillar [7].

Learning outcomes descriptions were also an input when developing the skills pillar of ESCO [8]. Combining functional analysis of occupations with the analysis of learning outcome descriptions ensures that the skills terminology covers use cases in both, the world of employment and of education and training.

2.2.2 Competence

ESCO applies the same definition of "competence" as the EQF. According to this "competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development." They are described in terms of responsibility and autonomy.

Example:

Working as a "civil airline pilot" requires the competence to combine knowledge on "emergency procedures" and "equipment malfunctions" with skills on "reading position coordinates" and "following the air route". This application of knowledge and skills takes place in a partly unpredictable setting where technical and organisational problems occur on a daily basis and where solutions have to be immediately identified and applied – either by the pilot alone or through team-working (e.g. involving the cabin crew or the ground staff).

2.2.3 Knowledge

ESCO applies the same definition for knowledge as the EQFhttps://ec.europa.eu/esco/portal/escopedia/European_Qualifications_Framework_40_EQF_41_. According to this, "knowledge means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study."

Both skills and competences rely on factual and theoretical knowledge, the difference lies in the way this knowledge is applied and being put into use.

Example:

Working as a "construction manager" requires the competence to combine knowledge on engineering principles with skills on project management and people management. This application of knowledge and skills takes place in a partly unpredictable setting where technical and organisational problems occur on a daily basis and where solutions have to be immediately identified and applied – either by the construction site manager alone or through team-working.

2.2.4 Skill

ESCO applies the same definition of "skill" as the EQF. https://ec.europa.eu/esco/portal/escopedia/European_Qualifications_Framework__40_EQF_41_According to this "skill means the ability to apply knowledge and use know-how to complete tasks and solve problems". They can be described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

While sometimes used as synonyms, the terms skill and competence can be distinguished according to their scope. The term skill refers typically to the use of methods or instruments in a particular setting and in relation to defined tasks. The term competence is broader and refers typically to the ability of a person - facing new situations and unforeseen challenges - to use and apply knowledge and skills in an independent and self-directed way.

2.2.5 Training module

A training module includes a set of learning units that are delivered using various means (i.e. online, face-to-face, blended) to get the students the desired competences in terms of knowledge and skills.

2.3 Development of DTAM curriculum

The DTAM curriculum has been developed taking into account European tools and instruments, like the EQF, ECVET and ESCO, ensuring its transferability and recognition among European countries.

The process followed for developing the DTAM curriculum will consist of three stages

- Defining curriculum goals and specific learning outcomes. For the case of the DTAM curriculum, its main goals are two:
    - Provide AM technicians with technical and non-technical competences that meet the industry's demand.
    - Develop an innovative AM learning ecosystem, that promotes problem-based learning, technology-enhanced learning, and experience-based learning

  Note that the learning outcomes of the DTAM curriculum, i.e. knowledge and skills of each separate training module, have been considering the ECVET recommendations [9].
- Developing relevant teaching methods and forms of assessment. At this stage is defining the methodology for the delivery of the DTAM curriculum in different learning scenarios, as well as the methodology for learners' assessment. As an initial approach, the DTAM curriculum will be delivered combing both online and face-to-face training exploiting the IoT labs that will be developed under WP4. For learners' assessment, we are currently considering both self-assessment and exercises/challenges. However, all the details about the training methodology of

the DTAM curriculum will be defined at the deliverable "D2.3: DTAM Training Methodology" under WP2.

- Reviewing and refining the curriculum. As the curriculum development is a continuous-learning process, the DTAM curriculum have been reviewed by the DTAM partners involved at the development of the training material (WP3), i.e., APRO, UPATRAS, ATLANTIS, DA VINCI, TXORRIERI and IDEC. Moreover, it will reviewer again after the completion of the pilots, in order to make fine-tuning changes based on their findings.

The separate training modules (courses) of the curriculum have been developed by each partner that is responsible to develop the respective training material under WP3. Thus

- APRO developed the "TM1: Information Technology and Operational Technology".
- UPATRAS developed the "TM2: Big Data".
- ATLANTIS developed the "TM3: Machine Learning".
- DA VINCI developed the "TM4: Internet of Things and sensors".
- TXORRIERI developed the "TM5: Cyber Security".
- IDEC developed the "TM6: Transversal Competences".

3 Curriculum Description

The DTAM curriculum follows a multi-disciplinary approach, combing technical with non-technical competences for AM technicians. It also follows a modular approach that support the need for micro-learning. The 6 training modules (courses) that consist of the DTAM curriculum are the following:

- TM1: Information Technology and Operational Technology
- TM2: Big Data
- TM3: Machine Learning
- TM4: Internet of Things and Sensors
- TM5: Cyber Security
- TM6: Transversal Competences

The description of each training module includes:

- Course name, code, duration and ECVET credits.
- Course description.
- Course objectives.
- Learning outcomes.
- Teaching and learning methods.
- Assessment methods.
- Learning units.
- Course outline

3.1 Description of training modules

3.1.1 TM1: Information Technology and Operational Technology

COURSE NAME	Information Technology and Operational Technology
COURSE CODE	IN
DURATION	40 hours
ECVET CREDITS	2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training)

COURSE DESCRIPTION
This training module aims to provide the learners with the basic knowledge and skills for the information technology, as well as the operational technology. It provides an overview of IT systems, IT networking and electronic fundamentals. As Python is the programming language that is used through the DTAM curriculum, this training module makes also an introduction to programming with Python. At the end of the module, you will learn the basics of Information and Operational Technology that are essentials for the AM technicians.

OBJECTIVES	
This unit aims to:	
O1	Provide basic information on managing Personal Computer and Raspberry hardware and software
O2	Illustrate the operation and configuration of computer network systems
O3	Approaching Python programming and the use of databases
O4	Provide basic training in the world of electronics, the fundamental laws of electrical engineering and the use of measuring instruments
O5	Developing green skills with reference to current sustainability regulations

LEARNING OUTCOMES		
EQF level 4 (VET) / EQF level 5+ (HE) *As the aim of introduction is to close the gap detected using the Digital Self Evaluation Tool, there is no difference between levels 4 and 5.*		Link to aims
By the end of the course, the students will (knowledge):		
K.A1	Know the fundamentals of PC systems and Raspberry PI, including hardware characteristics, operating systems, viruses, cyber attacks/dangers and URL Composition	O1
K.A2	Know the fundamentals of Networking, as the characteristics, the installation the configuration and the test of network components, the addressing system using IPv4 and Ipv6 standards, the difference among several network types, the Client/Server communication, the DNS functioning and some fundamentals about network troubleshooting	O2

K.A3a	Know the fundamentals of Phyton programming starting from the description of variables and types of data and arrays of data, passing trough the basic condiction instruction to the use of the Loop instructions and the creation of functions	O3
K.A3b	Know the fundamentals of Databases in order to recognize different types of DBs, their use and their main characteristics	O3
K.A5	Know the fundamental of Electronics, taking confidence with the most used electrical quantities and the components of a electrical system, analyzing the structure of basic electrical circuits, apply the fundamental physical laws of electronics, recognize several types of electrical actuators and sensor and use measurement instruments to check a circuit	O4
K.A5a	Be confident with Sustainability, knowing some energy saving techniques and alternative energy resources, how to avoid superfluous energy consumption, reduce waste and consumption of raw materials, reuse items, Minimize waste	O5
K.A5b	Know the international activities and legislation to improve the sustainability in the next future	O5
Moreover, by the end of the course, the students will be able to (skills):		
S.A1	Working with PC systems being able to: • Choose and install the Operative System • Choose and install an AntiVirus application • Check a system with an AntiVirus • Choose and install a Browser Web	O1
S.A2	Working with IT Network being able to: • Install and configure a network interface card • Install and configure a nework switch • Install and configure a network router • Recognize Internet Protocol parameters • Configure Internet Protocol parameters • Categorize different network types • Configurate the speed negotation between NIC and Switch • Test the commuincation between network components • Class choose and device IP address setting • Communicate with ICMP Protocol • Recognize HTTP/HTTPS protocol caracteristics • Recognize HTML caracteristics	O2
S.A3a	Programming Phyton being able to: • Use and configure variables • Use and configure arrays of data	O3

	• Use Condition and Loop instructions • Configure and use functions	
S.A3b	Work with a Database being able to: • Recognize different structures of database • Use queries and report	O3
S.A4	Working with basic Electronics being able to: • Measuring electrical quantities • Connecting actuators and sensors in a electrical system • Testing of a electrical circuit	O4
S.A5	Thinking about Sustainability being able to: • Be environmentally sensitive • Identify necessary energy resources for each task • Apply environmental friendly energy resources that effectively serve the purpose of the task • Have social responsibility	O5

TEACHING & LEARNING METHODS	Total Hours: 40
The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.	

ASSESSMENT METHODS
Self-assessment quizzes during the online courses Exercises to run at the IoT labs

LEARNING UNITS
PC systems • Introduction to the Personal Computer • Basic concepts of Information Technology • Structure of Computer • Interfaces • Central Processing Unit • Input devices • Output devices • Memory devices Mass

- Files and Folders
- Quick memories
- Software
- Single Board Computer
- Raspberry PI

Networking

- Networks Fundamentals
- The basic elements for creating a network
- Networking Technologies Overview
- Ethernet protocol
- The correct network connections
- Network Design Questions and Answers
- Short list of key networking components

Python & Database

- Python programming fundamentals
- Python introduction
- Programming fundamentals
- Arrays
- Decisions
- Loops
- Functions

Electronics

- Electronic Fundamentals
- Electrical quantities
- Fundamental laws
- Electronic signals
- Sensors & Actuators

Sustainability

- Sustainability
- Sustainability of development: terminology, circular economy and green economy
- Conscious use of resources in technology sector: raw materials, waste and energy
- Life Cycle Assessment (LCA)

OUTLINE	EQF level (4/5)	LOs	Week*	Estimated effort in hours
1 PC & Raspberry Pi fundamentals	4/5	A1	N/A	**6h**
1.1 Basic concepts of Information Technology				*4h*
1.2 Single Board Computer				*2h*
2 Networking Fundamentals	4/5	A2	N/A	**6h**
2.1 The basic elements for creating a network				*1h*
2.2 Networking Technologies Overview				*2h*
2.3 Ethernet protocol				*2h*
2.4 Network Design Questions and Answers				*1h*
3 Python & Database fundamentals	4/5	A3	N/A	**12h**
3.1 IT introduction				*1h*
3.2 Python introduction				*2h*
3.3 Programming fundamentals				*2h*
3.4 Program flow				*2h*
3.5 Functions				*3h*
3.6 Database Fundamentals				*2h*
4 Electronic Fundamentals	4/5	A4	N/A	**10h**
4.1 Electrical quantities				*3h*
4.2 Fundamental laws				*3h*
4.3 Electronic signals				*2h*
4.4 Sensors & Actuators				*2h*
5 Sustainability	4/5	A5	N/A	**6h**

OUTLINE	EQF level (4/5)	LOs	Week*	Estimated effort in hours
5.1 Sustainability of development: terminology, circular economy and green economy				*2h*
5.2 Conscious use of resources in technology sector: raw materials, waste and energy				*2h*
5.3 Life Cycle Assessment (LCA)				*2h*

**As the aim of introduction is to close the gap detected using the Digital Self Evaluation Tool, the temporal sequence is not predictable..*

3.1.2 TM2: Big Data

COURSE NAME	Big Data
COURSE CODE	BD
DURATION	50 hours
ECVET CREDITS	2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training)

COURSE DESCRIPTION
This course is for technicians and professionals who would like to understand the core tools used to wrangle and analyze big data, as well as the core tools used for distributed processing of large data sets across clusters of computers. Although the tools that are presented are generally applicable for data processing, analysis and visualization, the module is mainly oriented for advanced manufacturing use cases. At the end of the module, you will learn how to use Python for data analysis and data visualization. Moreover, you will learn how to use the Hadoop framework for distributed processing of large data sets.

OBJECTIVES	
The course aims to present topic for:	
O1	Carrying out data collection and integrating data storage systems.
O2	Using data processing techniques for decision making.
O3	Working with data generated within the industrial environment, from its capture and storage to its exploitation through data processing methods.
O4	Exploiting data to derive insights regarding the operation and maintenance of machines.
O5	Designing the architecture of an infrastructure for the distributed processing of big data.
O6	Communicating engaging data visualizations to support decisions towards the improvement of the digitized processes in industrial environments

LEARNING OUTCOMES		
EQF level 4 (VET)		Link to aims
By the end of the course, the students will get the following knowledge:		
K1a	Big data main characteristics	O1
K2a	Big data at advanced manufacturing	O1
K3a	The data analysis process and different types of data	O1, O2
K4a	How to use the Jupyter Notebook to write Python programs	O1, O2

K5a	Main Python tools for exporting and importing data	O1, O2, O3
K6a	Reading, different types of files in Python	O1, O2, O3
K7a	Missing values and how to handle them with Python	O1, O2, O3
K8a	Processing different types of data with Python	O1, O2, O3
K9a	The NumPy package in Python for the creation of large, multi dimensional arrays and matrices	O4
K10a	The Pandas library in Python for data analysis	O4
K11a	The Matplotlib library in Python for data visualization	O6
Moreover, by the end of the course, the students will get the following skills:		
Sa1	Preparing data for analysis using Python	O3
Sa2	Importing and Exporting Data in Python	O3
Sa3	Dealing with Missing Values in Python	O3
Sa4	Performing data preprocessing using Python	O3, O4
Sa5	Performing simple and complex data analysis using Python	O4
Sa6	Calculating basic statistics with Python	O4
Sa7	Performing data visualizations using Python	O6
EQF level 5+ (HE)		
By the end of the course, the students will get the following knowledge:		
K1b	Main features and components of Hadoop framework	O3, O5
K2b	The Hadoop Distributed File System	O3, O5
K3b	The Hadoop Yarn	O3, O5
K4b	The Hadoop MapReduce	O3, O5
K5b	Basic administration of an Hadoop cluster	O3, O5
K6b	How to develop MapReduce programs with Python	O3, O5
K7b	Pig programming language	O3, O5
Moreover, by the end of the course, the students will get the following skills:		
S1b	Using the Hadoop framework for data storage and processing	O3, O5
S2b	Using the storage (HDFS) and processing (YARN) services of Hadoop	O3, O5
S3b	Using the MapReduce framework	O3, O5
S4b	Submitting and managing jobs in Hadoop	O3, O5
S5b	Managing key Hadoop services	O3, O5
S6b	Writing simple MapReduce programs	O3, O5
S7b	Writing MapReduce program with Python	O3, O5

S8b	Using Pig programming language to interact with Hadoop	O3, O5

TEACHING & LEARNING METHODS	Total Hours: 50

The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.

The students will use the data collected by the IoT labs for data analysis and visualization using Python. Moreover, the students will use the data collected by the IoT labs for running large-scale data processing jobs at Hadoop.

ASSESSMENT METHODS

- Self-assessment quizzes during the online courses
- Exercises to run at the IoT labs
- Challenges to run at the IoT labs

LEARNING UNITS

- Introduction to Big Data
  - What is Big Data
  - Different types of data
  - Big data benefits
  - Big data applications for advanced manufacturing
  - The data analysis process and roles in data science projects
    - The data analysis process
    - Different roles in data science projects
- Introduction to Python for data analysis
  - Python installation
  - Using the Jupyter Notebook
  - Downloading files with Python
  - Main Python tools for exporting and importing data
  - Reading local files, XML files, JSON files and excel files
  - Missing values and how to handle them with Python
  - Processing of Raw Data to Tidy Data
  - Reading tabular data and large tables
  - Main libraries of Python for Data Analysis
- Python libraries for data analysis and visualization

- The NumPy library in Python for the creation of large, multi-dimensional arrays and matrices
    - The NumPy Array
    - The ndarray Class
    - Array Creation
    - Printing Arrays
    - Indexing, Slicing and Iterating
    - Shape Manipulation
- The Pandas library in Python for data analysis
    - Data Frame
    - Combine Data Frames
    - Rows and Columns Selection
    - Sorting
    - Descriptive Statistics
    - Group By
    - File I/O
- The Matplotlib library in Python for data visualization
    - Creating Basic Plots
    - Creating scatter 2D plots
    - Histograms and Density Plots
- The Apache Hadoop framework
    - Introduction to Hadoop
    - Hadoop advantages and disadvantages
    - The Hadoop Architecture and major components of Hadoop ecosystem
    - Hadoop clusters
    - Hadoop master-slave-topology
    - Single-node vs multi-node Hadoop clusters
    - Building an efficient Hadoop cluster
- The Hadoop Distributed File System
    - HDFS Architecture
    - Block replication in Hadoop
    - Rack Awareness
    - Hadoop HDFS Operations
    - Interacting with HDFS
- The Hadoop Yarn
    - Hadoop Yarn architecture

- Resource Manager
    - Node Manager
    - Application Master
    - Interacting with YARN
- The Hadoop MapReduce
    - What is MapReduce
    - MapReduce job execution flow
    - MapReduce data processing example
    - How Hadoop runs a MapReduce job
    - Hadoop streaming
    - Running a simple MapReduce job
- Hadoop Administration
    - Common commands for Hadoop administration
- Hadoop MapReduce with Python
    - Writing a MapReduce Program in Python using the Hadoop streaming utility
    - Writing a MapReduce Program in Python using mrjob
- Hadoop and Pig
    - Pig installation
    - Pig Latin
    - Writing a Pig script
    - Running Pig scripts

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
1 Introduction to Big Data				
1.1 Basic concepts of Big Data	4	K1a, K2a, K3a, K4a	1	3
1.2 Python for Data Analysis	4	K5a, K6a, K7a, K8a, Sa1, Sa2, Sa3, Sa4	1	3
2 Introduction to Python for data analysis				
2.1 The NumPy library in Python for the creation of large, multi-dimensional arrays and matrices	4	K9a, Sa5	2	5
2.2 The Pandas library in Python for data analysis	4	K10a, Sa6	3	5
2.3 The Matplotlib library in Python for data visualization	4	K11a, Sa7	3	4
3 The Apache Hadoop framework				
3.1 Basic concepts of Apache Hadoop	5	K1b	4	4
3.2 The Hadoop Distributed File System	5	K2b, S1b, S2b	4	4
3.3 The Hadoop Yarn	5	K3b, S2b, S3b	5	4
3.4 The Hadoop MapReduce	5	K4b, S3b	5	4
3.5 Hadoop Administration	5	K5b, S5b	6	4
3.6 Hadoop MapReduce with Python	5	K6b, S6b, S7b	6	4
3.7 Hadoop and Pig	5	K7b, S8b	7	6

3.1.3 TM3: Machine Learning

COURSE NAME	Machine Learning
COURSE CODE	ML
DURATION	50 hours
ECVET CREDITS	2 credits

COURSE DESCRIPTION
This course is for technicians and professionals who would like to understand the core tools used to implement machine learning techniques and analyze the shop floor data based on regression, classification, and clustering in order to train the systems for improved operations. The presented tools are the basic techniques and types of machine learning, the algorithms and the methods for it and their basic implementation in Python programming language. At the end of the module, one will learn the theoretics of machine learning, classification, regression, and clustering analysis. Moreover, the practical background with Python libraries and implementation will be covered by the modules.

OBJECTIVES	
This unit aims to:	
O1	Understand the fundamental concepts and principles of machine learning
O2	Gain practical knowledge and skills in implementing regression, classification, and clustering techniques
O3	Learn to analyze and interpret data using machine learning algorithms
O4	Apply machine learning models to real-world industrial scenarios
O5	Develop the ability to prepare and preprocess data for machine learning analysis
O6	Familiarize oneself with various supervised and unsupervised learning techniques
O7	Gain insights into advanced manufacturing applications of machine learning

LEARNING OUTCOMES		
EQF level 4 (VET)		Link to aims
By the end of the course, the students will get the following (knowledge):		
K1a K2a	Understanding of the theoretical principles of machine learning Understanding Machine Learning categories	O1
K3a	Knowledge of basic machine learning techniques such as regression, classification, and clustering.	O2

K4a	Familiarity with different types of machine learning, including supervised and unsupervised learning.	O6
K5a	Understanding of linear and non-linear regression models.	O3
K6a	Knowledge of classification and clustering techniques and their implementation in Python.	O6
K7a	Awareness of advanced manufacturing applications of machine learning.	O4, O7
K8a	Understanding of data analysis and interpretation using machine learning algorithms.	O3
Moreover, by the end of the course, the students will be able to (skills):		
Sa1	Acquire the ability to prepare and preprocess data for machine learning analysis using Python.	O5
Sa2	Develop the skills to implement machine learning models using Python libraries.	O4
EQF level 5+ (HE)		
By the end of the course, the students will gaining (knowledge):		
K1b	In-depth understanding of advanced machine learning concepts, algorithms, and methodologies.	O1
K2b	Knowledge of advanced regression techniques, including linear, non-linear, and polynomial regression, and their implementation in Python.	O3
K3b	Knowledge about ensemble methods such as random forests, AdaBoost, Bagging Classifier etc	O3
K4b	Knowledge regarding the definition, applications, advancements, interpretability challenges, and empirical nature of deep learning.	O3
K5b	Knowledge of unsupervised learning techniques such as dimensionality reduction, anomaly detection, and recommendation systems.	O6
K6b	Proficiency in feature engineering and feature selection techniques to optimize machine learning models.	O6
Moreover, by the end of the course, the students will be able to (skills):		
Sb1	Acquire the skills to design and implement complex machine learning models using advanced algorithms.	O4

TEACHING & LEARNING METHODS	Total Hours: 50 h
Lectures 30 h	
Practical sessions and exercises 10 h	
Case studies discussions 10 h	

ASSESSMENT METHODS

- Self-assessment quizzes during the online courses
- Exercises covering basic and advanced machine learning concepts, including dataset handling, model training and evaluation, data plotting, and real-life problem solving.
- Challenges involving interacting with real-world data, visualizing and preprocessing it, selecting an appropriate model, building and training it, evaluating the results, and documenting the process.

LEARNING UNITS

- Machine Learning Introduction
  - Definition
  - Machine Learning Categories
  - How it's made
  - Why insist on Machine Learning though?
  - Examples of machine learning use
  - Machine Learning advantages and disadvantages
  - Machine Learning for manufacturing applications
  - Global market examples
- Supervised Learning
  - What is supervised learning?
  - Mapping to real life Manufacturing Cases
  - Types of supervised learning
  - K Nearest Neighbor (kNN)
  - Advantages and disadvantages of Supervised Learning
- Python Unsupervised Learning
  - What is unsupervised learning?
  - Types of unsupervised learning
  - Unsupervised learning advantages
  - Unsupervised learning disadvantages
  - Classification vs clustering in machine learning
- Machine Learning - Regression with Python for ML
  - Linear Regression with Python
  - Multiple Linear Regression with scikit-learn
  - Polynomial Regression with Python

- Advanced Linear Regression with statsmodel
- Cost Function in the Linear Regression

- Classification and Decision trees in Python
  - Let's get started
  - Find the k nearest neighbors
  - Decision Trees in Python
  - Comparison of Decision Trees and KNN

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
1 Unit 1: Machine Learning - Introduction				**4h**
1.1 Definition	4/5	K1a	1	20min
1.2 Machine Learning Categories	4/5	K2a	1	20min
1.3 How it's made	4/5	K1a	1	20 min
1.4 Why insist on Machine Learning though?	4/5	K1a	1	1h
1.5 Examples of machine learning use	4/5	K1a	1	20min
1.6 Machine Learning advantages and disadvantages	4/5	K1a	1	20min
1.7 Machine learning for manufacturing applications	4/5	K1a, K4b	1	1h
1.8 Global market examples	4/5	K1a, K7a	1	20min
2 Unit 2: Supervised Learning			1	**10h**
2.1 What is supervised Learning?	4/5	K1a, K2a, K4a	1	20min
2.2 Mapping to real life Manufacturing Cases	4/5	K1a, K3a, K4a, K5a, K7a	1	20min
2.3 Types of supervised learning	4/5	K1a, K2a, K4a, K3b	1	6h
2.4 K Nearest Neighbor (kNN)	4/5	K3a, K4a, K5a	2	3h
2.5 Advantages and disadvantages of Supervised Learning	4/5	K3a, K4a, K5a, K4b	2	20min
3 Unit 3: Unsupervised Learning				**10h**
3.1 What is unsupervised Learning?	4/5	K3a, K4a, K5a	2	20min
3.2 Types of unsupervised learning	4/5	K3a, K4a, K5a, K5b	3	8h
3.3 Unsupervised learning advantages	4/5	K3a, K4a, K5a	3	20min
3.4 Unsupervised learning disadvantages	4/5	K3a, K4a, K5a	4	20min
3.5 Classification vs clustering in machine learning	4/5	K3a, K4a, K5a K6a, K5b	4	1h
4 Unit: Machine Learning – Regression with Python for ML				**16h**

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
4.1 Linear Regression with Python	4/5	K3a, K4a, K5a, K1b, Sa1, K8a	4	3h
4.2 Multiple Linear Regression with scikit-learn	4/5	K8a, K1b, Sa1, Sa2	5	3h
4.3 Polynomial Regression with Python	4/5	K8a, K1b, Sa1 Sa2	5	3h
4.4 Advanced Linear Regression with statsmodel	5	K6b, K1b, Sa1 Sa2	5	3h
4.5 Cost Function in the Linear Regression	5	K6b, K1b, Sa1 Sa2, , Sb1	6	4h
5 Unit Classification and Decision trees in Python				**10h**
5.1 Let's get started	4/5	K6b, Sa1, Sa2, Sb1	6	3h
5.2 Find the k nearest neighbors	4/5	K6b, Sa1, Sa2, Sb1	7	3h
5.3 Decision Trees in Python	4/5	K6b, Sa1, Sa2, Sb1	7	3h 50min
5.4 Comparison of Decision Trees and KNN	4/5	K6b, Sa1, Sa2, Sb1	7	10min

3.1.4 TM3: Advanced Sensors

COURSE NAME	Advanced Sensors
COURSE CODE	SC
DURATION	50 hours
ECVET CREDITS	2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training)

COURSE DESCRIPTION
The sensors module will enable learners to use different kinds of sensors on common devices (arduino, raspberry PI) and connect to a dashboard or message queue. The module uses Python as a programming language of choice, expanding on the Python fundamentals in module 1.

OBJECTIVES	
This unit aims to:	
O1	Choosing appropriate sensors for a problem domain.
O2	Choose suitable sensoring device based on problem criteria
O3	Assemble smart devices and sensors into a working prototype.
O4	Use wireless or wired communication to data storage/processing
O5	Use Python to gather sensor data and send to processing devices/database/queue.
O6	Visualize data into dashboards, warning systems, reports or actuators

LEARNING OUTCOMES		
EQF level 4 (VET) and EQF level 5 (HE)		Link to aims
By the end of the course, the students will get the following knowledge:		
K1	Different types of sensors	O1
K2	Sensor devices characteristics and differences	O2
K3	Steps to assemble prototypes with sensors	O3
K4	Wired communication protocols	O4
K5	Wireless communication protocols	O4
K6	Python commands and common libraries for communicating with sensors and communicate over networks	O5
K7	Different visualization systems characteristics and differences	O6
Moreover, by the end of the course, the students will get the following skills:		
S1	Assembling and troubleshooting hardware prototype using Arduino IDE	O1,O2,O3
S2	Importing Python libraries for common sensors	O5

S3	Write Python code to send sensor data to a MQTT queue	O5, O6
S4	Write Python code to send data to a MySQL database	O5
S5	Assemble and troubleshoot Raspberry PI with sensors	O3
S6	Query MySQL database from Python code	O4, O5
S7	Connect a dashboard to display sensor data	O6

TEACHING & LEARNING METHODS	Total Hours: 50
The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs. The students will listen to lecturers showing different approaches to solve problems, and demonstrate different sensors and devices. In the labs, different raspberry PI's and Arduino's are used to build prototypes. Students will work together in groups in a final challenge. The module can also be used to do exams for a certificate for module "K0730 programming microcontrollers", which is a part of the programs "IT Systems and devices" and "software developer" in The Netherlands.	

ASSESMENT METHODS
• Self-assessment quizzes during the online courses • Exercises to run at the IoT labs • Challenges to run at the IoT labs

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
1. Introduction to Advanced Sensors	**4 & 5**		**1**	**4**
1.1 Introduction	4 & 5	O1,O2	1	0,5
1.2 What is a sensor?	4 & 5	O1, K1a	1	0,5
1.3 IOT Networking	4 & 5	O4, K4a, K5a	1	0,5
1.4 System and application software	4 & 5	O5, K6	1	0,5
1.5 Connections to the web	4 & 5	K4, K5	1	0,5
1.6 Data storage	4 & 5	O2	1	0,5
1.7 Linux	4 & 5	O2	1	0,5
1.8 Quiz	4 & 5	O2, K2	1	0,5
2. Sensors	**4 & 5**		**2**	**12**
2.1 Overview	4 & 5	O2	2	0,5
2.2 Temperature / Humidity / Air pressure / Gas sensors	4 & 5	O1, K1, K2	2	1
2.3 Motion sensors	4 & 5	O1, K1, K2	2	0,5
2.4 Navigation modules	4 & 5	O1, K1, K2	2	0,5
2.5 Raspberry Pi Sensors – Wireless / Infrared (IR) / Bluetooth	4 & 5	O1, K1, K2	2	0,5
2.6 Motors	4 & 5	O1, K1, K2	2	0,5
2.7 Analogue Raspberry Pi Sensors	4 & 5	O1, K1, K2	2	0,5
2.8 Power/Current Supply	4 & 5	O1, K1, K2	2	0,5
2.9 Displays	4 & 5	O1, K1, K2	2	0,5
2.10 Other modules, components and Raspberry Pi Sensors	4 & 5	O1, K1, K2	2	0,75

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
2.11 Quiz	4 & 5	O1, K1, K2	2	0,25
2.12 Exercise 1: Reading Out RFID RC522 Tags (NFC)	4 & 5	O3, O5, K3, S1, S2, S4, S5	3	2
2.13 Exercise 2: Controlling an HD44780 LCD display via I2C	4 & 5	O3, O5, K3, S1, S2, S4, S5	3	2
2.14 Exercise 3: Using a distance sensor (ultrasonic sensor HC-SR04)	4 & 5	O3, O5, K3, S1, S2, S4, S5	3	2
3. Using a device to work with sensors	4 & 5		**4**	**4**
3.1 Using a device to work with sensors	4 & 5	O2, K2, S1	4	1
3.2 Arduino Uno R3	4 & 5	O2, K2, S1	4	1
3.3 Raspberry Pi 4 and Raspberry 3B+	4 & 5	O2, K2, S1	4	1
3.4 Quiz	4 & 5		4	1
4. Programming IoT with Python on a Raspberry Pi	**4 & 5**		**5**	**16**
4.1 Using Python as IoT programming language	4 & 5	O5, K6	5	0,5
4.2 Arguments for using Python for IoT	4 & 5	O5	5	0,5
4.3 Book: "The Coder's Apprentice" by Pieter Spronck	4 & 5	O5, K6, S1, S2, S3, S4, S5, S6	5, 6	12
4.4 Project: physical computing by Raspberry Pi Foundation	4 & 5	O5, K6, S1, S2, S3, S4, S5, S6	7	1
4.5 Exercise: operating a "traffic light" from Python code	4 & 5	O5, K6, S1, S2, S3, S4, S5, S6	7	2
5. Wired communication	**4 & 5**		**8**	**2**
5.1 KNX	4 & 5	O4, K4	8	1

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
5.2 PLC	4 & 5	O4, K4	8	1
6. Wireless communication	**4 & 5**		**8**	**4**
6.1 Wi-Fi	4 & 5	O4, K5	8	0,5
6.2 LoRa	4 & 5	O4, K5	8	0,5
6.3 Bluetooth	4 & 5	O4, K5	8	0,5
6.4 4G/5G Cellular networks	4 & 5	O4, K5	8	0,5
6.5 433MHz	4 & 5	O4, K5	8	0,5
6.6 Z-Wave	4 & 5	O4, K5	8	0,5
6.7 Zigbee	4 & 5	O4, K5	8	0,5
6.8 Quiz	4 & 5		8	0,5
7 Data visualisation platforms	4 & 5		**9**	**8**
7.1 Data visualisation with Grafana	4 & 5	O6, K7, S7, S6	9	1
7.2 Open platform for interacting sensors (Home Assistant)	4 & 5	O6, K7, S7, S6	9	1
7.3 Processing data with NodeRed	4 & 5	O6, K7, S7, S6	9	2
7.4 Exercise: Connection of Siemens PLC to Raspberry PI & NodeRed	4 & 5	O6, K7, S7, S6	9	4

3.1.5 TM4: Cybersecurity

COURSE NAME	Cybersecurity
COURSE CODE	Cyb
DURATION	50 hours during 6 weeks
ECVET CREDITS	2 ECVET credits (assuming that 1 ECVET corresponds to 25 hours of training)

COURSE DESCRIPTION
This course is for technicians and professionals who would like to define and implement security strategies in industrial organizations and infrastructures. At the end of the module you will learn how to perform cybersecurity diagnostics, identifying vulnerabilities and implementing the necessary measures to mitigate them, applying the necessary measures to mitigate them by applying the current regulations and industry standards, following the sector standards, following the protocols of quality, occupational risk prevention and environmental respect.

OBJECTIVES	
This unit aims to:	
O1	Make the students familiar with the fundamentals of industrial cybersecurity
O2	Understand the cybersecurity implications in Advanced Manufacturing Industry
O3	Define a cyber secure architecture for Smart Factories
O4	Present the most important cyber threats for Smart Factories
O5	Explain what are the most important cybersecurity measures and techniques
O6	Present what is a cybersecurity diagnosis report

LEARNING OUTCOMES		
EQF level 4 (VET)		Link to aims
By the end of the course, the students will get the following knowledge:		
K1a	Understanding of the changes needed for the IT /OT convergence	O1
K2a	Basic understanding of industrial control systems (ICS)	O2,O3
K3a	Types of cybersecurity hazards	O4
K4a	Types of credentials and access control systems (Digital signatures…)	O5
K5a	Main concepts of zoning and segmentation in ICS	O4, O5
K6a	Basic principles of data security	O5
K7a	Basic principles of access controls	O5

K8a	Basic principles of secure coding	O5
Moreover, by the end of the course, the students will get the following skills:		
Sa1	Segment an industrial network	O3, O5
Sa2	Identify people, devices and systems	O5
Sa3	Propose solutions for secure remote access	O4,O5
Sa4	Propose solutions for secure industrial communications	O4,O5
Sa5	Propose solutions for data security	O4,O5
EQF level 5+ (HE)		
By the end of the course, the students will get the following knowledge:		
K1b	Understanding of the changes needed for the IT /OT convergence	O1
K2b	Basic understanding of industrial control systems (ICS)	O2,O3
K3b	Industrial communication networks and protocols	O2
K4b	Types of cybersecurity hazards	O4
K5b	Types of credentials and access control systems (Digital signatures…)	O5
K6b	Main concepts of zoning and segmentation in ICS	O4, O5
K7b	Know what is the vulnerability management system (CVE…)	O5
K8b	Main industry standards and applicable regulations related to cybersecurity	O3
K9b	Main features of cybersecurity policies and measures	O3, O5
K10b	Network control and supervision devices for secure communications in ICS (IDS, IPS…)	O5
K11b	Basic principles of data security	O5
K12b	Basic principles of access controls	O5
K13b	Basic principles of secure coding	O5
K14b	Relevant information for cybersecurity reports	O6
Moreover, by the end of the course, the students will get the following skills:		
S1b	Analyze IT and OT environments	O2,O3
S2b	Implement IT/OT network coupling	O2,O3
S3b	Segment an industrial network	O3,O5
S4b	Search for information on known vulnerabilities in industrial control systems.	O4
S5b	Identify Vulnerabilities	O4
S6b	Identify people, devices and systems	O4, O5
S7b	Identify the cybersecurity main policies in an organization	O3,O5
S8b	Analyze the features of the communication protocols	O3,O5
S9b	Propose solutions for secure remote access	O4,O5
S10b	Propose solutions for secure industrial communications	O4,O5
S11b	Apply Intrusion detection systems (IDS)	O4,O5

S12b	Apply standards for secure communications	O4,O5
S13b	Propose solutions for data security	O4,O5

TEACHING & LEARNING METHODS	Total Hours: 50

The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ as well as hands-on sessions at the IoT labs.

Students will perform a network discovery test with the available informatic tools in order to inventory the existing equipment. The available equipment could be industrial PLC´s and HMI´s, different type of devices (raspberry, Arduino, different sensors…) and servers. The connexions should be secured using tools such as VPN and digital signatures/certificates. The Students will create a cybersecurity policy to improve the system.

ASSESMENT METHODS	

- Self-assessment quizzes during the online courses
- Exercises to run at the IoT labs
- Challenges to run at the IoT labs

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
1 IT/OT enviroment features				
1.1 Definition of IT/OT	4/5	K1a, K2a	1	2
1.2 Cybersecurity for IT/OT integration	4/5	K1a, K1b	1	2
2 Risk Scenarios				
2.1 Types of ICS	4/5	K2a, K2b, K3b	1	2
2.2 Physical and logical network architecture	4/5	K2a, K2b, K3b	2	4
2.3 Types of hazards	4/5	K3a, K4b, S5b	2	4
2.4 External risks and cyberattacks	4/5	K3a, K4b, S5b	3	4
2.5 Common vulnerabilities and exposures	5	K7b, S4b, S5b	3	1
3 Cybersecurity policies				
3.1 Industry standards and regulations	5	K8b, S7b	3	2
3.2 Cybersecurity policies	5	K9b, S7b	3	4
4 Securing industrial networks				
4.1 Zoning and segmentation	4/5	K5a, S1a, K6b, S1b, S2b, S3b	4	4
4.2 secure communications	4/5	K6a, S2a, S3a, S4a, K10b, S1b, S2b, S6b, S8b,S9b,S10b,S12b	4	6
4.3 Data security	4/5	K6a, S5a, K11b, S10b, S13b	5	4
4,4 Access control and credentials	4/5	K4a, K7a, K5b, K12b, S6b	5	2
4.5 Secure coding	4/5	K8a, K13b	5	1
5 Securing industrial networks				
5.1 Anomaly monitoring and detection	5	K10b, S11b	6	3

OUTLINE	EQF level (4/5)	LOs	Week	Estimated effort in hours
5.2 IDS, IPS and SIEM tools	5	K10b, S11b		2
6 Cybersecurity reports				
6.1 Cybersecurity diagnosis and reports	5	K14b	6	3

3.1.6 TM6: Transversal Competences

COURSE NAME	Transversal Competences
COURSE CODE	TM6
DURATION	25 hours
ECVET CREDITS	1

COURSE DESCRIPTION
This course is for technicians and professionals who would like to access and improve the learning process in a different and pioneering way. At the end of the module, on a personal level students will have the ability to achieve individual learning, adapt to different situations, find innovative ideas, and surpass difficulties. It is well known that a strong and complete personality is the first step on professional success. Furthermore, on a social level you will be able to communicate with other people and cooperate properly. Finally, students will enrich their knowledge with the ability to handle big information volume effectively.

OBJECTIVES	
This unit aims to:	
O1	Provide the tools and information for self-learning
O2	Enable students to enhance their critical thinking, flexibility, and adaptability to new situations, through methods, procedures, and techniques to increase the effectiveness of changes.
O3	Enhance problem-solving competences
O4	Empower communication skills, team working and cooperation through strategies and principles on creating strong teams.
O5	Empower leadership skills, handling responsibilities and decisions
O6	Enhance the value of respect and interculturalism
07	Strengthen the ability to collect and analyse information, controlling their validity
08	Offer the tools and knowledge for effective project management, risk assessment and project closure.

LEARNING OUTCOMES		
EQF level 4 (VET)		Link to aims
By the end of the course, the students will (knowledge):		
K.A1	Learn by doing, capitalizing new knowledge and new opportunities to learn whilst critically assessing the resources. Have deeper knowledge of an effective self-learning process, have the tools to boost creativity and use them for upskilling and finding new opportunities.	O1
K.A2	Have knowledge on ways to make successful changes, being flexible in their professional and personal lives, collaborate successfully and don't be afraid to take necessary risks. Have a deeper knowledge on critical thinking and its components, know the abilities of critical thinkers and be able to apply them in order to ensure innovation and progress.	O1,O2
K.A3	Have knowledge on problem solving techniques, research and analytical skills, understand the steps of effective problem-solving processes. Understand creativity techniques and know how to apply them.	O3
K.A4	Know how to use effective communication methods and skills in their professional and personal life. Have deeper knowledge on methods of communication, active listening and the set of principles to achieve effective communication processes. Through this they will also know the importance of cooperation and teamwork, as well as strategies to create well-balanced teams.	O4
K.A5	Know the characteristics of a good leader and understand the importance of having a strong team. Have deeper knowledge and understanding of leadership and the characteristics of a successful leader. They will know the importance of taking initiatives as well as ways to lead their team.	O5
K.A6	Know the value of different cultures and appreciate interculturalism, through mutual respect. Have deeper knowledge on the essence of interculturalism which is necessary in the professional world today, forms and elements of intercultural communication and ways to avoid any occurring obstacles to intercultural collaboration and communication.	O6
K.A7	Know how to collect and analyse information. Have deeper knowledge on information and data analysis, types of information analysis and data analysis and control the reliability of information and resources.	O7
K.A8	Know what a project consists of, and how to effectively manage a project from the beginning to its end. Have deeper knowledge on project management, know the project's lifecycle, planning and implementation. They will also acquire knowledge regarding risk analysis, and planning tools that help guide the organizational action steps related to projects.	O8
Moreover, by the end of the course, the students will be able to (skills):		

S.A1	Have communication skills, presentation skills, verbal and written communication skills, empathy and open mindedness. Collaboration skills/ Team Management Skills/ Networking skills/ Stress Management Skills/ Negotiation Skills/ Conflict Resolution Skills	O1
S.A2	Have skills on identification and definition of problems. Research skills Analytical skills	O2
S.A 3	Have the skills to resolve problems, using their creativity and critical thinking	O3
S.A 4	Have the skills to effectively communicate in their personal and professional lives.	O4
S.A5	Have the skills to become good leaders and create strong teams around them.	O5
S.A 6	Have the skills to work and collaborate with people from different cultures.	O6
S.A 7	Have the skills to collect and analyse information, and check their validity.	O7
S.A 8	Have skills to manage projects from the beginning to their finalization. They will have planning skills, risk assessment skills which are crucial in project management.	O8
EQF level 5+ (HE)		
By the end of the course, the students will (knowledge):		
K.B 1	Learn by doing, capitalizing new knowledge and new opportunities to learn whilst critically assessing the resources. Have deeper knowledge of an effective self-learning process, have the tools to boost creativity and use them for upskilling and finding new opportunities.	O1
K.B2	Have knowledge on ways to make successful changes, be flexible in their professional and personal lives, collaborate successfully and don't be afraid to take necessary risks. Have a deeper knowledge on critical thinking and its components, know the abilities of critical thinkers and be able to apply them in order to ensure innovation and progress.	O2
K.B3	Have knowledge on problem solving techniques, research and analytical skills, understand the steps of effective problem-solving processes. Understand creativity techniques and know how to apply them.	O3
K.B4	Know how to use effective communication methods and skills in their professional and personal life. Have deeper knowledge on methods of communication, active listening and the set of principles to achieve effective communication processes. Through this they will also know the importance of	O4

	cooperation and teamwork, as well as strategies to create well-balanced teams.	
K.B5	Know the characteristics of a good leader and understand the importance of having a strong team. Have deeper knowledge and understanding of leadership and the characteristics of a successful leader. They will know the importance of taking initiatives as well as ways to lead their team.	O2,O3, O4,O5
K.B6	Know the value of different cultures and appreciate interculturalism, through mutual respect. Have deeper knowledge on the essence of interculturalism which is necessary in the professional world today, forms and elements of intercultural communication and ways to avoid any occurring obstacles to intercultural collaboration and communication.	O6
K.B7	Know how to collect and analyse information. Have deeper knowledge on information and data analysis, types of information analysis and data analysis and control the reliability of information and resources.	O7
K.B8	Know what a project consists of, and how to effectively manage a project from the beginning to its end. Have deeper knowledge on project management, know the project's lifecycle, planning and implementation. They will also acquire knowledge regarding risk analysis, and planning tools that help guide the organizational action steps related to projects.	O4, O5,O8
Moreover, by the end of the course, the students will be able to (skills):		
S.B1	They will have the skills to: critically analyze situations Change strategies and mindset to adapt to new situations/ critically analyze former strategies and their application to new situations/ Create new strategies/ Innovation Thinking Identification and definition of problems Research skills Analytical skills Break down the issue to its critical components. Create alternative solutions. Evaluate alternative solutions. Risk assessment skills	O1
S.B2	Advising/ coaching/ conflict resolution/ decision making/ diplomacy/ team spirit/ cooperation Acceptability/ globalization/ broad reach of interests Analytical Skills Identification of critical components of an issue Critical Thinking towards information Planning and Organizing Skills Goal setting and Management skills	O2

S.B 3	Have skills on problem solving techniques, research and analytical skills, understand the steps of effective problem-solving processes. Skills to apply creativity techniques in their professional and personal life.	O3
S.B 4	Skills to use effective communication methods in their professional and personal life. Have deeper knowledge on methods of communication, and the skills to actively listen. Through this they will also gain the skills of cooperation and teamwork, as well as strategies to create well-balanced teams.	O4
S.B5	Skills and characteristics of a good leader and the skills to create a strong team. They will have the skills to take initiatives as well as ways to lead their team.	O3, O4,O5
S.B6	Skills to appreciate interculturalism, through mutual respect. Skills to appreciate the essence of interculturalism which is necessary in the professional world today, forms and elements of intercultural communication and ways to avoid any occurring obstacles to intercultural collaboration and communication.	O6
S.B7	Skills to collect and analyse information, data analysis, types of information analysis and data analysis and the skills to control the reliability of information and resources.	O7
S.B8	Skills to effectively manage a project from the beginning to its end. Skills to become effective project managers.Skills on project management, understanding the project's lifecycle, planning and implementation. They will also acquire skills regarding risk analysis, and planning tools that help guide the organizational action steps related to projects.	O3, O4,O5, O8

TEACHING & LEARNING METHODS	Total Hours: 25
The training methods that will be used to deliver the course are online courses at the MOOC https://e-training.dtamproject.eu/ • Self-assessment quizzes during the online courses • Exercises to run at the IoT labs • Challenges to run at the IoT labs	

LEARNING UNITS
Self-learning

- Definition of the term
- Benefits of self-learning
- 1.3 Seven steps for an effective self-learning process
- 1.4 The six C' s of Self Learning
- Self-learning after the pandemic
- 1.6 Self-learning as a tool to boost creativity
- 1.7 Self-learning as a tool for upskilling and new opportunities
- 1.8 Self-learning as a supporting mechanism for developing other transversal skill

Flexibility & Critical Thinking

- 2.1 Flexibility and Adaptability
- 2.2 Flexibility and adaptability to new situations
- 2.3 Characteristics of an adaptable and flexible person
- 2.4 Ways to make successful changes
- 2.5 Methods, procedures, and techniques to increase the effectiveness of changes
- 2.6 Critical and Innovative Thinking
- 2.7 Process of critical thinking
- 2.8 The components of critical thinking
- 2.9 Critical thinking abilities
- 2.10 The meaning of innovative thinking
- 2.11 Ten ways to develop innovative ideas

Problem Solving

- 3.1 Problem Solving definition
- 3.2 Why are problem solving skills essential today
- 3.3 Problem-solving skills
- 3.4 Problem solving as a complex mental process
- 3.5 Nine steps of an effective problem-solving process
- 3.6 Creativity techniques
- 3.7 Creative Problem Solving
- 3.8 SCAMPER

Communication and Cooperation

- 4.1 Definition of the term
- 4.2 Methods of communication
- 4.3 Why are communication skills so important today?
- 4.4 Effective communication
- 4.5 Main set of principles to achieve effectiveness in communication

- 4.6 Cooperation-Team Working
- 4.7 Definition of Cooperation
- 4.8 Which are the benefits of an effective collaboration, especially after the stress caused by the COVID-19 pandemic
- 4.9 Strategies to create a well-balanced and efficient team

Leadership

- 5.1Definition of leadership
- 5.2 The complexity of leadership
- 5.3 Taking charge of initiatives
- 5.4 The characteristics of a successful leader
- 5.5 Effective ways to lead your team

Globalization

- 6.1Intercultural understanding
- 6.2 Basic forms and elements of intercultural communication
- 6.3 Different cultures and ways of thinking
- 6.4 Obstacles to an effective intercultural communication
- 6.5 How to improve your intercultural skills
- 6.6 Value of acceptance

Information and data analysis

- 7.1 Information analysis
- 7.2 Types of Information analysis
- 7.3 Data analysis
- 7.4 Information vs Data
- 7.5 Types of data analysis
- 7.6 Control reliability of information

Project Management

- 8.1 Project and Project Management definition
- 8.2 Project Lifecycle
- 8.3 Project Planning and Implementation
- 8.4 Risk analysis
- 8.5 Planning tools
- 8.6 The importance of communication
- 8.7 Change of management
- 8.8 Necessary steps for a successful change management process

OUTLINE	EQF level (4/5)	LOs	Estimated effort in hours
Module 1: Self-learning	4/5	EQF LEVEL 4/5	**3**
1.1 Definition of the term	4/5	KA.1, KB.1,SA.1,SB.1	20 min
1.2 Benefits of self-learning	4/5	KA.1,KB.1, SA.1,SB.1	20 min
1.3 Seven steps for an effective self-learning process	4/5	KA.1,KB.1, SA.1,SB.1	30 min
1.4 The six C' s of Self Learning	4/5	KA.1,KB.1, SA.1,SB.1	20 min
1.5 Self-learning after the pandemic	4/5	KA.1,KB.1, SA.1,SB.1	20 min
1.6 Self-learning as a tool to boost creativity	4/5	KA.1,KB.1, SA.1,SB.1	30 min
1.7 Self-learning as a tool for upskilling and new opportunities	4/5	KA.1,KB.1, SA.1,SB.1	20 min
1.8 Self-learning as a supporting mechanism for developing other transversal skills	4/5	KA.1,KB.1, SA.1,SB.1	20 min
Module 2: Flexibility & Critical Thinking	4/5	EQF LEVEL 4/5	**3**
2.1 Flexibility and Adaptability	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	15 min
2.2 Flexibility and adaptability to new situations	4/5	KA.1,KB.1, SA.1,SB.2.,KA.2,KB.2,S.A.2,S.B.2	15 min
2.3 Characteristics of an adaptable and flexible person	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	15 min
2.4 Ways to make successful changes	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	15 min

OUTLINE	EQF level (4/5)	LOs	Estimated effort in hours
2.5 Methods, procedures, and techniques to increase the effectiveness of changes	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	20 min
2.6 Critical and Innovative Thinking	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	15 min
2.7 Process of critical thinking	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	15 min
2.8 The components of critical thinking	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	20 min
2.9 Critical thinking abilities	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	15 min
2.10 The meaning of innovative thinking	4/5	KA.1,KB.1, SA.1,SB.1, KA.2,KB.2,S.A.2,S.B.2	15 min
2.11 Ten ways to develop innovative ideas	4/5	KA.1,KB.1, SA.1,SB.1,KA.2,KB.2,S.A.2,S.B.2	20 min
Module 3: Problem Solving	4/5	EQF LEVEL 4/5	**3**
3.1 Problem Solving definition	4/5	K.A3, K.B3,S.A3,S.B3	20 min
3.2 Why are problem solving skills essential today	4/5	K.A3, KB.3,S.A3,S.B3	20 min
3.3 Problem-solving skills	4/5	K.A1, K.B1, K.A3, K.B3, S.A3,S.B3	20 min
3.4 Problem solving as a complex mental process	4/5	K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3	25 min
3.5 Nine steps of an effective problem-solving process	4/5	K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3	30 min

OUTLINE	EQF level (4/5)	LOs	Estimated effort in hours
3.6 Creativity techniques	4/5	K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3	20 min
3.7 Creative Problem Solving	4/5	K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3	20 min
3.8 SCAMPER	4/5	K.A1,K.B1, K.B1,K.B2,K.A3,K.B3 S.A1,S.B1,S.A3,S.B3	25 min
Module 4: Communication and Cooperation	4/5	EQF LEVEL 4/5	**3**
4.1 Definition of the term	4/5	K.A4,K.B4,S.A4,S.B4	20 min
4.2 Methods of communication	4/5	K.A4,K.B4,S.A4,S.B4	20 min
4.3 Why are communication skills so important today?	4/5	K.A4,K.B4,S.A4,S.B4	20 min
4.4 Effective communication	4/5	K.A4,K.B4,S.A4,S.B4	20 min
4.5 Main set of principles to achieve effectiveness in communication	4/5	K.A4,K.B4,S.A4,S.B4	20 min
4.6 Cooperation-Team Working	4/5	K.A4,K.B4,S.A4,S.B4	20 min
4.7 Definition of Cooperation	4/5	K.A4,K.B4,S.A4,S.B4	20 min
4.8 Which are the benefits of an effective collaboration, especially after the stress caused by the COVID-19 pandemic	4/5	K.A4,K.B4,S.A4,S.B4	20 min

OUTLINE	EQF level (4/5)	LOs	Estimated effort in hours
4.9 Strategies to create a well-balanced and efficient team	4/5	K.A4,K.B4,S.A4,S.B4	20 min
Module 5: Leadership	4/5	EQF LEVEL 4/5	**3**
5.1Definition of leadership	4/5	K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5	35 min
5.2 The complexity of leadership	4/5	K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5	35 min
5.3 Taking charge of initiatives	4/5	K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5	35 min
5.4 The characteristics of a successful leader	4/5	K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5	35 min
5.5 Effective ways to lead your team	4/5	K.A1,K.B1,K.A5,K.B5,S.A1,S.B1,S.A5,S.B5	40 min
Module 6: Globalization	4/5	EQF LEVEL 4/5	**3**
6.1Intercultural understanding	4/5	K.A6,K.B6,S.A6,S.B6	30 min
6.2 Basic forms and elements of intercultural communication	4/5	K.A6,K.B6,S.A6,S.B6	30 min
6.3 Different cultures and ways of thinking	4/5	K.A6,K.B6,S.A6,S.B6	30 min
6.4 Obstacles to an effective intercultural communication	4/5	K.A6,K.B6,S.A6,S.B6	30 min
6.5 How to improve your intercultural skills	4/5	K.A6,K.B6,S.A6,S.B6	30 min
6.6 Value of acceptance	4/5	K.A6,K.B6,S.A6,S.B6	30 min
Module 7: Information and data analysis	4/5	EQF LEVEL 4/5 .	**3**
7.1 Information analysis	4/5	K.A7,K.B7,S.A7,S.B7	30 min

OUTLINE	EQF level (4/5)	LOs	Estimated effort in hours
7.2 Types of Information analysis	4/5	K.A7,K.B7,S.A7,S.B7	30 min
7.3 Data analysis	4/5	K.A7,K.B7,S.A7,S.B7	30 min
7.4 Information vs Data	4/5	K.A7,K.B7,S.A7,S.B7	30 min
7.5 Types of data analysis	4/5	K.A7,K.B7,S.A7,S.B7	30 min
7.6 Control reliability of information	4/5	K.A7,K.B7,S.A7,S.B7	30 min
Module 8: Project Management	4/5	EQF LEVEL 4/5	**4**
8.1 Project and Project Management definitions	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min
8.2 Project Lifecycle	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min
8.3 Project Planning and Implementation	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min
8.4 Risk analysis	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min
8.5 Planning tools	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min
8.6 The importance of communication	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min
8.7 Change of management	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min

OUTLINE	EQF level (4/5)	LOs	Estimated effort in hours
8.8 Necessary steps for a successful change management process	4/5	K.A1,K.B1,K.A4,K.B4,K.A5,K.B5,K.A8,K.B8 S.A1,S.B1,S.A4,S.B4,S.A5,S.B5,S.A8,S.B8	30 min

4 References

[1] CEDEFOP, Defining, writing and applying learning outcomes.

[2] EC, Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning.

[3] ESCO, Knowledge definition.

[4] ESCO, Skill definition.

[5] ESCO, Competence definition.

[6] ESCO, Qualification definition.

[7] ESCO, ESCO qualification pillar.

[8] ESCO, ESCO Skills pillar.

[9] ECVET, Identify Units of Learning Outcomes.

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