



Artificial Intelligence Technician

Job Role Skill Set



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



DOCUMENT TITLE

Report Title:	Artificial Intelligence Technician Job Role Skills Set		
Author(s):	Dr. José Machado (UMINHO)		
Responsible Project Partner:	UMINHO	Contributing Project Partners:	VSB-TUO, IPV

Document data:	Status:	(draft/ <u>final</u>)	Dissemination level:	Public
Project title:	Development and Research on Innovative Vocational Educational Skills		GA No.:	2017-3295/001-001.
WP title:	WP3 – Skills Framework		Project No.:	591988-EPP-1-2017-1-CZ-EPPKA2-SSA-B
			Deliverable No:	D3.1
			Submission date:	30/04/2020
Keywords:	automotive sector, skill card, skill set, job roles, ECTS, ECVET			
Reviewed by:	Damjan Ekert (Formal Review)		Review date:	30/04/2020
			Review date:	
Approved by:	Anke Blume Richard Messnarz		Approval date:	30/04/2020

More information about DRIVES project and contact:

www.project-drives.eu

TABLE OF CONTENTS

Document title	1
Table of Contents	2
Introduction	4
1.1 Objective.....	4
1.2 Purpose of the Deliverable	4
1.3 Scope of the Deliverable	4
2 ECQA Skills Definition Model	5
3 Skills Definition for the Job Role “aRTIFICIAL Intelligence technician”	7
3.1 The Skills Hierarchy	7
3.2 The Skills Descriptions – Job Role ARTIFICIAL INTELLIGENCE TECHNICIAN.....	8
3.3 Unit AIT.U1 Introduction to Artificial Intelligence.....	8
3.3.1 Unit AIT.U1 - Element 1: What is artificial intelligence?	9
3.3.2 Unit AIT.U1 - Element 2: Artificial Intelligence Applications, Use Cases and Real-Life Examples	9
3.4 Unit AIT.U2 Machine Learning	10
3.4.1 Unit AIT.U2 - Element 1: Machine Learning Overview	10
3.4.2 Unit AIT.U2 - Element 2: Algorithms of Machine Learning: Supervised, Unsupervised, Semi-Supervised and Reinforcement Learning	11
3.4.3 Unit AIT.U2 - Element 3: Recommendation Systems	11
3.5 Unit AIT.U3 Deep Learning and Neural Networks.....	12
3.5.1 Unit AIT.U3 - Element 1: The Human Brain and its Computationally Modelling	13
3.5.2 Unit AIT.U3 - Element 2: Disclosure of the Learning Problems.....	13
3.5.3 Unit AIT.U3 - Element 3: Fundamental Concepts and Terminologies of Deep Learning Neural Networks.....	14
3.5.4 Unit AIT.U3 - Element 4: Neural Networks Topology.....	14
3.5.5 Unit AIT.U3 - Element 5: Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN)	15



3.5.6	Unit AIT.U3 - Element 6: Advanced Architectures	16
3.5.7	Unit AIT.U3 - Element 7: Deep Learning Applications and Real-Life Examples.....	16
3.5.8	Unit AIT.U3 - Element 8: The Future Trends in Artificial Intelligence	17
Annexes		19
Annex A ECQA Description		19
ECQA – European Certification and Qualification Association.....		19
ECQA Skills Definition Model.....		20
ECQA Skill Set Strategy		20
ECQA Skills Assessment Model.....		20
ECQA Certificate Types.....		22
Annex B ECQA Coverage of Qualification Schemas		24
Mapping based on NVQ Qualification Levels		24
Mapping based on European Qualification Framework (EQF) Learning Levels		25
Mapping based on ECTS and ECVET Schema		26
ECTS Mapping.....		26
ECVET Mapping		27
Annex C ECQA Legal Background For Certification		28
ISO/IEC 17024 standard for personnel certification programmes.....		28
ECQA and ISO/IEC 17024 standard.....		28
LIASION with National Universities		28
Annex D References		29



INTRODUCTION

1.1 OBJECTIVE

The objective of this deliverable is to provide an introduction to described Job Role within the applied skills definition model.

1.2 PURPOSE OF THE DELIVERABLE

The purpose of this deliverable is to define skills definitions of the Artificial Intelligence Technician job role within the ECQA skills definition model.

1.3 SCOPE OF THE DELIVERABLE

The deliverable contains

- Description of the content of the Job Role
- Description of used Skill Sets and skills definitions, coverage of Qualification Schemas

The deliverable does not cover:

- Course development, as this will be done after the skill definitions clearly outlined the set of required courses.

2 ECQA SKILLS DEFINITION MODEL

A skills definition contains the following items (see Fig. 1):

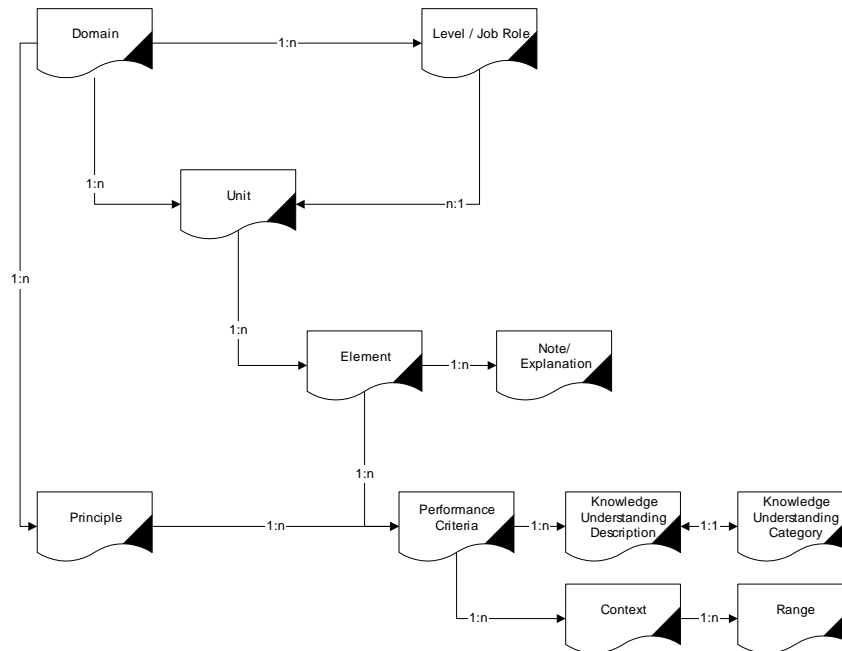


Figure 1 The Skill Definition Model (1:n = one to many relationship)

Context: A category of ranges; it represents some terminology used in a performance criterion that consists of different context, conditions or circumstances. A participant must be able to prove competence in all the different circumstances covered by the context.

Domain: An occupational category, e.g. childcare, first level management or software engineering.

Element: Description of one distinct aspect of the work performed by a worker, either a specific task that the worker has to do or a specific way of working. Each element consists of a number of performance criteria.

Evidence: Proof of competence.

Knowledge and understanding category: A category of knowledge and understanding descriptions.

Knowledge and understanding description: A description of certain knowledge and understanding. To be judged competent in a unit a participant must prove to have and to be able to apply all the knowledge and understanding attached to it.

NVQ (UK based): The National Vocational Qualification standard of England, Wales and N. Ireland.



Performance criterion: Description of the minimum level of performance a participant must demonstrate in order to be assessed as competent. A performance criterion may have relevant contexts.

Principle: A statement of good intentions; it underpins all competent domain practice.

Range: Description of a specific circumstance and condition of a performance criterion statement.

Qualification: The requirements for an individual to enter, or progress within a certain occupation.

Job Role: A certain profession that covers part of the domain knowledge. E.g. domain = Functional Safety, job role = Functional Safety Manager.

Unit: A list of certain activities that have to be carried out in the workplace. It is the top-level skill in the UK qualification standard hierarchy and each unit consists of a number of elements.

The rationales for developing the ECQA skills definition model is based on the skills definition proposed by the DTI (Department of Trade and Industry) in the UK for the NVQ (National Vocational Qualification) standards. These models have been re-used and slightly modified by other countries when they started employing skill cards [1], [2].

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). Further description and rationales are attached in annexes of this document. The ECQA structure was mapped in DRIVES project to DRIVES Reference and Recognition Framework with the links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

3 SKILLS DEFINITION FOR THE JOB ROLE “ARTIFICIAL INTELLIGENCE TECHNICIAN”

3.1 THE SKILLS HIERARCHY

Using the terminology outlined in the skills definition model and including the skills identified during the demand analysis at the beginning of the project, the following skills hierarchy for the job role “Artificial Intelligence Technician” has been designed.

Unit ID	Unit Name	Element ID	Element Name
AIT.U1	Introduction to Artificial Intelligence	AIT.U1.E1	What is Artificial Intelligence (AI)?
		AIT.U1.E2	AI Applications, Use Cases, and Real-Life Examples
AIT.U2	Machine Learning	AIT.U2.E1	Machine Learning Overview
		AIT.U2.E2	Algorithms of Machine Learning: Supervised, Unsupervised, Semi-Supervised and Reinforcement Learning
		AIT.U2.E3	Recommendation Systems
AIT.U3	Deep Learning and Neural Networks	AIT.U3.E1	The Human Brain and its Computationally Modelling
		AIT.U3.E2	Disclosure of the Learning Problems
		AIT.U3.E3	Fundamental Concepts and Terminologies of Deep Learning Neural Networks
		AIT.U3.E4	Neural Networks Topology
		AIT.U3.E5	Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN)
		AIT.U3.E6	Advanced Architectures
		AIT.U3.E7	Deep Learning Applications and Real-Life Examples
		AIT.U3.E8	The Future Trends in Artificial Intelligence: Machine Intelligence and the Hierarchical Temporal Memory (HTM)

Table 1 : The Skills Set for ECQA Certified Artificial Intelligence Technician

3.2 THE SKILLS DESCRIPTIONS – JOB ROLE ARTIFICIAL INTELLIGENCE TECHNICIAN

Domain Acronym: Engineering

Domain title: Artificial Intelligence in Automotive

Domain Description:

The field of Artificial Intelligence aims to design computer programs and/or machines which simulate intelligence to mimic human cognitive abilities. Artificial Intelligence is a broad science which includes thinking models, cognitive and knowledge-based systems, problem solving, and decision making. In the automotive industry, the upcoming fully autonomous vehicles will rely heavily on Artificial Intelligence to perceive its environment, reduce the reaction time, and perform the better action according to a rigorous assessment of the consequences of each action and the projection of the different scenarios possible in order to maximize the safety of all interveners, including the driver and passengers inside the car, other human beings in another cars, pedestrians and animals. Artificial Intelligence can also be used to enhance the experience inside the car, enabling a more comfortable, and pleasant ride experience according to user preferences.

Job Role Acronym: AIT

Job Role Title: Artificial Intelligence Technician

Description:

The Skill card comprises the following thematic learning units

Unit 1 – Introduction to Artificial Intelligence

Unit 2 – Machine Learning

Unit 3 – Deep Learning and Neural Networks

3.3 UNIT AIT.U1 INTRODUCTION TO ARTIFICIAL INTELLIGENCE

Acronym: AIT.U1

Title: Introduction to Artificial Intelligence

Description:

The first unit is an introduction to artificial intelligence that provides learners a detailed description of AI and its main particularities. It consists of the following learning elements:

E1 – What is Artificial Intelligence?



E1.1 – Artificial Intelligence Overview.

E1.2 – The Progress and History of Artificial Intelligence

E1.3 – The Philosophical Problems Surrounding Artificial Intelligence: Issues, Concerns and Ethical Considerations

E2 – Artificial Intelligence Applications, Use Cases and Real-Life Examples

3.3.1 Unit AIT.U1 - Element 1: What is artificial intelligence?

Acronym: AIT.U1.E1

Element Title: What is Artificial Intelligence?

Element Note:

This learning element describes the concept of Artificial Intelligence based on its definition, origin, evolution over the years, contributions and, also, constraints.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U1.E1.PC1	The student is able to define artificial intelligence.
AIT.U1.E1.PC2	The student understands the need, purpose and impacts of artificial intelligence.
AIT.U1.E1.PC3	The student understands the differences between data, information, knowledge, understanding/insight and wisdom.
AIT.U1.E1.PC4	The student is able to deduce how to gain strategic advantage through the use of different kinds of intelligence.
AIT.U1.E1.PC5	The student understands the origin and evolution of artificial intelligence over the years.
AIT.U1.E1.PC6	The student recognizes and critically understands the issues and ethical concerns surrounding artificial intelligence.

Table 2: Performance Criteria for the Element AIT.U1.E1

3.3.2 Unit AIT.U1 - Element 2: Artificial Intelligence Applications, Use Cases and Real-Life Examples

Acronym: AIT.U1.E2

Element Title: Artificial Intelligence Applications, Use Cases and Real-Life Examples

Element Note:

This learning element focus on the applicability of Artificial Intelligence, offering an elaborated overview of the main areas of knowledge and applications of AI through real-life examples and use cases.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U1.E2.PC1	The student knows the different application domains of artificial intelligence.
AIT.U1.E2.PC2	The student is able to analyse and discuss several examples and applications of artificial intelligence.
AIT.U1.E2.PC3	The student recognizes the challenges surrounding artificial intelligence approaches.
AIT.U1.E2.PC4	The student can assess the impact of artificial intelligence on the future of work and society.
AIT.U1.E2.PC5	The student is able to reflect about the future of artificial intelligence.

Table 3: Performance Criteria for the Element AIT.U1.E2

3.4 UNIT AIT.U2 MACHINE LEARNING

Acronym: AIT.U2

Title: Machine Learning

Description:

The second unit of this job role is an introduction to machine learning, a particular branch of artificial intelligence, and provides learners a brief overview of Machine Learning, its algorithms and its main characteristics. It consists of the following learning elements:

E1 – Machine Learning Overview

E2 – Algorithms of Machine Learning: Supervised, Unsupervised, Semi-Supervised and Reinforcement Learning

E3 – Recommendation Systems

3.4.1 Unit AIT.U2 - Element 1: Machine Learning Overview

Acronym: AIT.U2.E1

Element Title: Machine Learning Overview

Element Note:

This learning element describes the concept of Machine Learning based on its definition and contributions.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U2.E1.PC1	The student understands the connection between artificial intelligence and machine learning.
AIT.U2.E1.PC2	The student knows how to define machine learning.
AIT.U2.E1.PC3	The student is able to explain the value proposition of machine learning and understand its particularities and key features.

Table 4: Performance Criteria for the Element AIT.U2.E1

3.4.2 Unit AIT.U2 - Element 2: Algorithms of Machine Learning: Supervised, Unsupervised, Semi-Supervised and Reinforcement Learning

Acronym: AIT.U2.E2

Element Title: Algorithms of Machine Learning: Supervised, Unsupervised, Semi-Supervised and Reinforcement Learning

Element Note:

This learning element provides an overview of the different types of Machine Learning algorithms.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U2.E2.PC1	The student can list the different types of machine learning methods.
AIT.U2.E2.PC2	The student knows how to define and explain the different machine learning methods as well as the conditions of use of each method.

Table 5: Performance Criteria for the Element AIT.U2.E2

3.4.3 Unit AIT.U2 - Element 3: Recommendation Systems

Acronym: AIT.U2.E3

Element Title: Recommendation Systems

Element Note:

This learning element provides a description of recommendation systems and its connection with machine learning.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U2.E3.PC1	The student understands the theoretical concepts about recommendation systems.
AIT.U2.E3.PC2	The student is able to explore different applications and examples of recommendation techniques.
AIT.U2.E3.PC3	The student knows how to analyse and implement user and item-based recommendation techniques.

Table 6: Performance Criteria for the Element AIT.U2.E3

3.5 UNIT AIT.U3 DEEP LEARNING AND NEURAL NETWORKS

Acronym: AIT.U3

Title: Deep Learning and Neural Networks

Description:

The last unit of this job role is an introduction to deep learning, a particular branch of artificial intelligence, and neural networks. It provides learners an elaborated description of Deep Learning, differentiating it from Machine Learning and Artificial Intelligence. It consists of the following learning elements:

E1 – The Human Brain and its Computationally Modelling

E2 – Disclosure of the Learning Problems

E3 – Fundamental Concepts and Terminologies of Deep Learning Neural Networks

E4 – Neural Networks Topology

E5 – Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN)

E6 – Advanced Architectures

E7 – Deep Learning Applications and Real-Life Examples

E8 – The Future Trends in Artificial Intelligence: Machine Intelligence and the Hierarchical Temporal Memory (HTM)

3.5.1 Unit AIT.U3 - Element 1: The Human Brain and its Computationally Modelling

Acronym: AIT.U3.E1

Element Title: The Human Brain and its Computationally Modelling

Element Note:

This learning element describes the constitution, functioning and purpose of the human brain and explains what a computational neuron is. In addition, this element gives an overview of the most common activation functions.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E1.PC1	The student knows the structure of a biological human neuron as well as the functions of its constituents.
AIT.U3.E1.PC2	The student understands the nature, purpose and applications of an artificial neuron.
AIT.U3.E1.PC3	The student is able to recognize and understand the similarities between a computational neuron and a human neuron
AIT.U3.E1.PC4	The student knows the most commonly used activation functions for artificial neurons.

Table 7: Performance Criteria for the Element AIT.U3.E1

3.5.2 Unit AIT.U3 - Element 2: Disclosure of the Learning Problems

Acronym: AIT.U3.E2

Element Title: Disclosure of the Learning Problems

Element Note:

This learning element gives an overview of the most common learning problems and provides insights on the role of Artificial Intelligence to help mitigate those problems.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E2.PC1	The student is able to identify several learning problems.
AIT.U3.E2.PC2	The student understands how AI can help solve those problems.

Table 8: Performance Criteria for the Element AIT.U3.E2

3.5.3 Unit AIT.U3 - Element 3: Fundamental Concepts and Terminologies of Deep Learning Neural Networks

Acronym: AIT.U3.E3

Element Title: Fundamental Concepts and Terminologies of Deep Learning Neural Networks

Element Note:

This learning element gives an important description and distinction of Artificial Intelligence, Machine Learning and Deep Learning, as well as, an explanation of how these concepts are connected. Additionally, this element provides the definition of a neural network and establishes the connection between big data and deep learning.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E3.PC1	The student is able to define and explain AI concepts and terms like machine learning, deep learning and neural networks.
AIT.U3.E3.PC2	The student understands the connection and the differences between artificial intelligence, machine learning and deep learning.
AIT.U3.E3.PC3	The student is able to define and explain what an artificial neural network is.
AIT.U3.E3.PC4	The student understands the relationship between deep learning and big data.

Table 9: Performance Criteria for the Element AIT.U3.E3

3.5.4 Unit AIT.U3 - Element 4: Neural Networks Topology

Acronym: AIT.U3.E4

Element Title: Neural Networks Topology

Element Note:

This learning element gives a detailed description of neural networks' architecture focusing on its constituents, the organization of those constituents, the architectures of the conventional neural networks and their applicability.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E4.PC1	The student understands the key parameters in a neural network's architecture.
AIT.U3.E4.PC2	The student knows some of the most common neural networks like perceptron, multi-layer perceptron, feed-forward, backpropagation, etc.
AIT.U3.E4.PC3	The student understands the main differences between those types of architectures.
AIT.U3.E4.PC4	The student knows the different use cases of each architecture.
AIT.U3.E4.PC5	The student is able to critically select the architecture that best fits a specific problem or situation.

Table 10: Performance Criteria for the Element AIT.U3.E4

3.5.5 Unit AIT.U3 - Element 5: Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN)

Acronym: AIE.U3.E5

Element Title: Convolutional Neural Network (CNN) and Recurrent Neural Network (RNN)

Element Note:

This learning element gives a detailed description of CNN and RNN focusing on its definition and use cases. In addition, this element provides insights on how to choose the better architecture to a specific problem or situation. Finally, this element explains how to make RNN and CNN implementations with TensorFlow.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E5.PC1	The student is able to define CNN and RNN.
AIT.U3.E5.PC2	The student understands the differences between CNNs and RNNs.
AIT.U3.E5.PC3	The student knows the different use cases of CNNs and RNNs.
AIT.U3.E5.PC4	The student is able to select the architecture that best fits a specific problem or situation.
AIT.U3.E5.PC5	The student is able to implement RNN and CNN with TensorFlow.

Table 11: Performance Criteria for the Element AIT.U3.E5

3.5.6 Unit AIT.U3 - Element 6: Advanced Architectures

Acronym: AIT.U3.E6

Element Title: Advanced Architectures

Element Note:

This learning element provides an overview of the advanced architectures of artificial neural networks.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E6.PC1	The student knows that there are other artificial neural networks architectures.
AIT.U3.E6.PC2	The student understands the most commonly used advanced architectures and their particularities.
AIT.U3.E6.PC3	The student is able to explore and understand some examples of the application of advanced ANN architectures.

Table 12: Performance Criteria for the Element AIT.U3.E6

3.5.7 Unit AIT.U3 - Element 7: Deep Learning Applications and Real-Life Examples

Acronym: AIT.U3.E7

Element Title: Deep Learning Applications and Real-Life Examples

Element Note:

This learning element focus on the applicability of Deep Learning, offering an elaborated overview of the main areas of knowledge and applications of Deep Learning through real-life examples and use cases. In addition, this element provides insights on the development, training, deployment and assessment of a deep neural network as well as the challenges associated with this process.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E7.PC1	The student knows different application domains of deep learning.
AIT.U3.E7.PC2	The student is able to explore and analyse several examples and applications of deep learning.



Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E7.PC3	The student understands the challenges surrounding deep learning approaches.
AIT.U3.E7.PC4	The student is able to identify the ingredients required to start a deep learning project.
AIT.U3.E7.PC5	The student is able to train a deep neural network.
AIT.U3.E7.PC6	The student knows how to deploy deep neural networks into applications.
AIT.U3.E7.PC7	The student is able to identify techniques for improving the performance of deep learning applications.
AIT.U3.E7.PC8	The student recognizes the challenges and the importance of deep learning.

Table 13: Performance Criteria for the Element AIT.U3.E7

3.5.8 Unit AIT.U3 - Element 8: The Future Trends in Artificial Intelligence

Acronym: AIT.U3.E8

Element Title: The Future Trends in Artificial Intelligence

Element Note:

This learning element focus on the future of Artificial Intelligence, offering insights on recent and possible incoming trends of AI, focusing specifically in Machine Intelligence and the Hierarchical Temporal Memory.

Performance Criteria:

The student must be able to show evidence of competencies for the following performance criteria/skills (PCs):

Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E8.PC1	The student is able to reflect on and analyse the future trends for artificial intelligence.
AIT.U3.E8.PC2	The student understands and knows how to define machine intelligence.
AIT.U3.E8.PC3	The student understands the HTM approach for unsupervised learning.
AIT.U3.E8.PC4	The student is able to compare the different neuron models.



Performance Criterion	Evidence Check: The student can demonstrate
AIT.U3.E8.PC5	The student is able to analyse and understand the applications of HTM.

Table 14: Performance Criteria for the Element AIT.U3.E8



ANNEXES

The annex provides overview of used skills set, coverage of Qualification Schemas and Legal background for Certification

ANNEX A ECQA DESCRIPTION

ECQA – EUROPEAN CERTIFICATION AND QUALIFICATION ASSOCIATION

ECQA standards are used to describe the skills sets delivered within the DRIVES project (www.project-drives.eu). ECQA is the pilot Certification body, which structure is mapped to DRIVES Reference and Recognition Framework providing the EU-wide overview of training courses and possible certifications, and micro-credentials. DRIVES Reference and Recognition Framework provides links to ESCO[7], EQF[8], ECTS[9] and ECVET[10]. See more in deliverable DRIVES-D4.1.1 Reference and Recognition Framework – Analysis.pdf (www.project-drives.eu).

Europe Wide Certification

The ECQA is the result of a number of EU supported initiatives in the last ten years where in the European Union Life Long Learning Programme different educational developments decided to follow a joint process for the certification of persons in the industry.

Through the ECQA it becomes possible that you attend courses for a specific profession in e.g. Spain and perform a Europe wide agreed test at the end of the course.

Access to a Vast Pool of Knowledge

ECQA currently supports 27 professions in Europe and with the continuous support until 2012 by the European Commission the pool is growing to 30 certified professions in Europe. ECQA offers certification for professions like IT Security Manager, Innovation Manager, EU project manager, E-security Manager, E-Business Manager, E-Strategy Manager, SW Architect, SW Project Manager, IT Consultant for COTS selection, Internal Financial Control Assessor (COSO/COBIT based), Interpersonal Skills, Scope Manager (Estimation Processes), Configuration Manager, Safety Manager, and so forth.

The ECQA guide can be downloaded at www.ecqa.org -> Guidelines.

Defined procedures are applied for:

- Self assessment and learning



- http://www.ecqa.org/fileadmin/documents/Self_Assessment/eucert-users-self-assessment-learning-guide-v5-doc.pdf
- Exam performance
- http://www.ecqa.org/fileadmin/documents/ECQA_Exam_Guide_Participant_v2.pdf

ECQA SKILLS DEFINITION MODEL

The ECQA skills definition model, used for Job Role definition, is described in section 2 of this document.

ECQA SKILL SET STRATEGY

Imagine that in the future Europeans will have a skill set like a card with a chip which stores your skill profile to fulfil specific professions, job roles, and tasks. It's working like an ID card. This future scenario requires -

- A standard way to describe a skill set for a profession, job, or specific task.
- A standard procedure to assess the skill and to calculate and display skill profiles.

Such a common set of skill sets in Europe is needed due to the free mobility of workers. European countries such as UK, The Netherlands, and France already have well established open universities which support APL (Accreditation of Prior Learning). In APL the skills of students are assessed, already gained skills are recognised, and only for the skill gaps a learning plan is established. The skill assessment bases on defined skill units and a skill profile displaying how much of the skill units are covered.

In a previous project CREDIT (Accreditation of Skills via the Internet) [1] in which some of the project partners were involved such an Internet based skills assessment system has been built. Therefore another possible scenario of the future is that representative educational bodies per country in Europe maintain skill profiles in databases which can be accessed via defined ID codes for people.

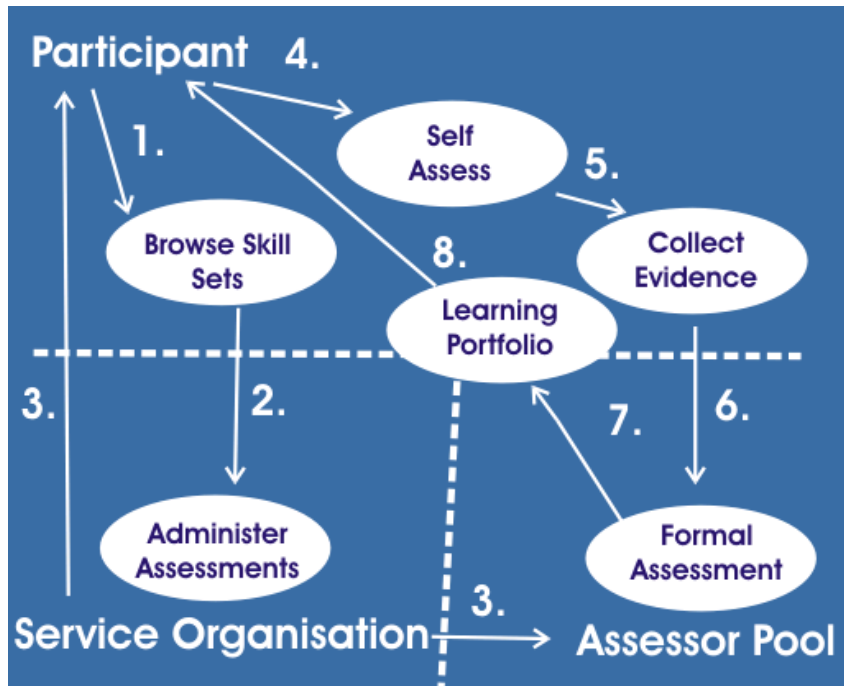
ECQA SKILLS ASSESSMENT MODEL

Step 1 – Browse a Skills Set: You select a set of skills or competencies, which are required by your profession or job using national standards or your company standards. You browse different skills cards and select a job role you would like to achieve.

Step 2 – Register for Self Assessment with a Service Unit : This can be a service unit inside your own company (e.g. a personnel development department) or a skills card and assessment provider outside

your company which offers skills assessment services. In case of the Safety Manager Project the registration will automatically assign a predefined service unit.

Step 3 – Receive an Account for Self-Assessment and Evidence Collection : With the registration you automatically received an account to login to the working space in which you can go through the steps of online self assessment and the collection of evidences to prove that you are capable of certain performance criteria.



Picture 1: Basic steps of the skills assessment model

Step 4 – Perform Self Assessment: You log into the system , browse through the skills required and self assess performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. A skills gaps profile can be generated and printed illustrating in which areas your self assessment shows improvement potentials.

Testing of Skills (Addition to Step 4) – The system provides a multiple-choice test for each performance criteria so that you can check your capabilities as realistically as possible.

Step 5 – Collect Evidences: Before you want to enter any formal assessment you need to prove your skills by evidences. Evidences can be any electronic files (sample documents, sample graphics, results of some analysis, etc.) or any references with details (e.g. a certificate received from a certain



institution). Evidences you can then link to specific performance criteria or whole elements of skills units.

Testing of Skills (Addition to Step 5) – In traditional learning schemes people have always needed to go to a learning institution (university, accreditation body, professional body, etc.) to take exams and they received a certificate if they pass. This traditional approach however is insufficient when it comes to measuring experience and (soft) skills learned on the job and fails to give recognition to skills gathered on the job. The APL (Accreditation of Prior Learning) approach, by contrast, collects so called evidences. Evidences can be certificates obtained in the traditional way, but also references from previous employers, materials from previous projects in which the person took ownership of results (e.g. a test plan) to prove their capability, as well as any kind of proof of competence gathered on the job. The assessors will then evaluate the evidences provided and not only rely on certificates and exams.

Step 6 – Receive Formal Assessment: Formal assessors are assigned by the service unit to the skills assessment. Once formal assessors log into the system they automatically see all assigned assessments. They select the corresponding one and can see the uploaded evidences. They then formally assess the evidences and assess the formal fulfilment of performance criteria, whole elements or whole units with a standard evaluation scale of non-applicable, not adequate, partially adequate, largely adequate, and fully adequate. In case of missing competencies they enter improvement recommendations, as well as learning options.

Step 7 – Receive Advise on Learning / Improvement Options: After the formal assessment the participants log into the system and can see the formal assessment results from the assessors, can print skills gaps profiles based on the assessor results, and can receive and print the improvement recommendations and learning options. If required, the generation of learning options can also be automated through the system (independent from assessor advises).

ECQA CERTIFICATE TYPES

In the standard test and examination procedures for levels of certificates are offered:

- Course Attendance Certificate
 - Received after course attendance
 - Modular per Element
- Course / Test Certificate
 - Test in a test system (European pool of test questions)
 - 67% satisfaction per element



- Summary Certificate
 - Overview of covered elements where the student passed the test, all elements shall be covered
 - Generation of certificate
- Professional Certificate
 - Uploading applied experiences for review by assessors
 - Rating by assessors
 - Observation of 2 years

The certificates show credited elements in comparison to all required.



ANNEX B ECQA COVERAGE OF QUALIFICATION SCHEMAS

MAPPING BASED ON NVQ QUALIFICATION LEVELS

Qualification / training levels: Five levels of qualification / training are defined by European legislation and this structure can be used for comparability of vocational qualifications from the different European countries.

- Level 1: semi-skilled assistant performing simple work
- Level 2: basic employee performing complex routines and standard procedures
- Level 3: skilled professional with responsibility for others and performing independent implementation of procedures
- Level 4: middle management & specialist performing tactical and strategic thinking
- Level 5: professional / university level

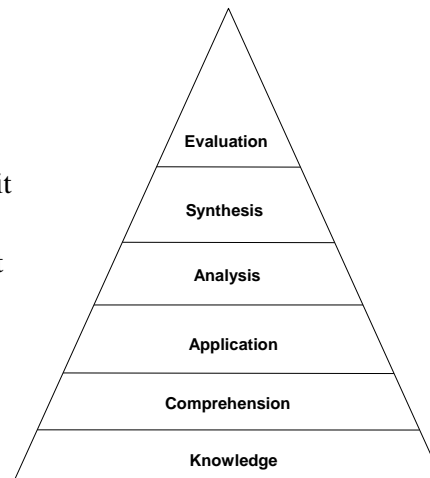
In most cases the same job role can be offered on different levels. e.g. IT Security Manager Basic Level (NVQ level 2), IT Security Manager Advanced level (NVQ Level 3), and IT Security Manager Expert Level (NVQ Levels 4 and 5).

MAPPING BASED ON EUROPEAN QUALIFICATION FRAMEWORK (EQF) LEARNING LEVELS

- **Six level taxonomy:**

Level 0: I never heard of it

1. Knowledge (I can define it):
2. Comprehension (I can explain how it works)
3. Application (I have limited experience using it in simple situations)
4. Analysis (I have extensive experience using it in complex situations)
5. Synthesis (I can adapt it to other uses)
6. Evaluation (I am recognized as an expert by my peers)



Picture 3: Blooms Learning levels

Level	Knowledge	Example
Level 1	Basic general knowledge	
Level 2	Basic factual knowledge of a field of work or study	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	Six Sigma Yellow Belt
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	
Level 5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Six Sigma Green Belt
Level 7	<ul style="list-style-type: none"> • Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research • Critical awareness of knowledge issues in a field and at the interface between different fields 	Six Sigma Black Belt

Level	Knowledge	Example
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	Six Sigma Master Black Belt

Picture 4 : EQF Learning levels

MAPPING BASED ON ECTS AND ECVET SCHEMA

ECQA has established a procedure to map ECQA skills sets onto the ECTS (European Credit Transfer System) and the ECVET framework in the European Union.

A job role is assigned ECTS and ECVET points using a defined framework.

ECTS Mapping

Each element of the skills set is assigned hours of lecturing and exercises. These hours determine the ECTS points which are then agreed among a cluster on different universities in Europe.

Level	Knowledge	AQUA	ECTS	Safety Manager	ECTS
Level 1	Basic general knowledge	-		-	
Level 2	Basic factual knowledge of a field of work or study	-		-	
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study				
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study				
Level 5	Comprehensive, specialized, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge				
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	AQUA - Automotive Quality Integrated Skills - presentations / theory	3	AQUA - Automotive Quality Integrated Skills - presentations / theory	3
Level 7	- Highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research - Critical awareness of knowledge issues in a field and at the interface between different fields	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4	AQUA - Automotive Quality Integrated Skills - with exercises to apply on nan example (e.g. ESCL)	4
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5	AQUA - Automotive Quality Integrated Skills - implementation in a research at PhD level / with link to a real project	5

Picture 5 : Example Automotive Quality Engineer and Safety Manager

The 2 job roles illustrated in the picture above have been assigned to ECTS and are taught using the same skills set at industry and also universities.



ECVET Mapping

Also ECQA provides a framework to assign ECVET points onto elements of the skills set. The ECQA guidance recommends to offer the ECQA course (which is offered as a lecture at university) as a short course (2 weeks with exercises) in industry to retrain for a job role in industry. The recommended size is 30 ECVET points in total. The lecturing time and exercise per element determine how many ECVET points are assigned to an element of the skills set.

Automotive Quality Engineer			
			ECVET L7&8
U1	4	U1.E1: Introduction	2
		U1.E2: Organisational Readiness	2
U2	32	U2.E1 Life Cycle	8
		U2.E2 Requirements	8
		U2.E3 Design	8
		U2.E4 Test and Integration	8
U3	12	U3.E1: Capability	2
		U3.E2: Hazard and Risk Management	8
		U3.E3 Assessment and Audit	2
U4	12	U4.E1: Measurement	6
		U4.E2: Reliability	6
ECVET Points Total			60

Picture 6 : ECVET Mapping example - Automotive Quality Engineer

Functional Safety Manager / Engineer			
			ECVET L7&8
U1	2	U1.E1 International Standards	1
		U1.E2 Product Life Cycle	1
		U1.E3 Terminology	
U2	4	Safety management on organisational	1
		Safety Case Definition	1
		Overview of Required Engineering an	1
		Establish and Maintain Safety Plannin	1
U3	16	System Hazard Analysis and Safety Co	4
		Integrating Safety in System Design &	4
		Integrating Safety in Hardware Design	4
		Integrating Safety in Software Design	4
U4	4	Integration of Reliability in Design to I	2
		Safety in the Production, Operation an	2
U5	4	Legal aspects and Liabilities	2
		Regulatory & Qualification Requireme	2
ECVET Points Total			30

Picture 7 : ECVET Mapping example – Functional Safety Manager / Engineer



ANNEX C ECQA LEGAL BACKGROUND FOR CERTIFICATION

ISO/IEC 17024 STANDARD FOR PERSONNEL CERTIFICATION PROGRAMMES

The ISO/IEC 17024 standard describes standard processes for the examination and certification of people. Some of the basic principles described include:

- Standard exam procedure
- Standard certification procedure
- Identification of persons receiving the certificate
- Independence of examiner and trainer
- Certification system that allows to log the exam to keep a record/proof that the examinee passed the exam
- Mapping of processes towards ISO 17024

ECQA AND ISO/IEC 17024 STANDARD

- ECQA defined standard exam processes
- ECQA defined standard certification processes
- ECQA developed an exam system that generates random exams and corrects exams.
- ECQA developed a certification database to identify persons and map them to exam results
- ECQA established a mapping onto the ISO 17024 norm and published that in form of a self declaration.

LIASION WITH NATIONAL UNIVERSITIES

ECQA established cooperation with national universities who teach job roles with ECTS. The same job roles are offered with ECVET on the market by training bodies.



ANNEX D REFERENCES

- [1] *CREDIT Project, Accreditation Model Definition, MM 1032 Project CREDIT*, Version 2.0, University of Amsterdam, 15.2.99
- [2] DTI - Department of Trade and Industry UK, **British Standards for Occupational Qualification, National Vocational Qualification Standards and Levels**
- [3] R. Messnarz, et. al, **Assessment Based Learning centers**, in : Proceedings of the EuroSPI 2006 Conference, Joensuu, Finland, Oct 2006, also published in Wiley SPIP Proceeding in June 2007
- [4] Richard Messnarz, Damjan Ekert, Michael Reiner, Gearoid O'Suilleabhain, **Human resources based improvement strategies - the learning factor (p 355-362)**, Volume 13 Issue 4 , Pages 297 - 382 (July/August 2008), Wiley SPIP Journal, 2008
- [5] European Certification and Qualification Association, **ECQA Guide**, Version 3, 2009, www.ecqa.org, Guidelines
- [6] Richard Messnarz, Damjan Ekert, Michael Reiner, **Europe wide Industry Certification Using Standard Procedures based on ISO 17024**, in: Proceedings of the TAAE 2012 Conference, IEEE Computer Society Press, June 2012
- [7] The European Skills/Competences, qualifications and Occupations (ESCO), <https://ec.europa.eu/esco/portal/home>
- [8] The European Qualifications Framework (EQF), <https://www.cedefop.europa.eu/en/events-and-projects/projects/european-qualifications-framework-eqf>
- [9] European Credit Transfer and Accumulation System (ECTS), https://ec.europa.eu/education/resources-and-tools/european-credit-transfer-and-accumulation-system-ects_en
- [10] The European Credit system for Vocational Education and Training (ECVET), https://ec.europa.eu/education/resources-and-tools/the-european-credit-system-for-vocational-education-and-training-ecvet_en