SEnDIng

D4.1

RECOMMENDATIONS FOR VALIDATION, CERTIFICATION & ACCREDITATION OF PROVIDED VET PROGRAMMES

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Document Version-Status:	SEnDINg_DLV4.1-final
Submission date:	M24
Dissemination level:	Public

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

Deliverable factsheet

Project Number:	591848-EPP-1-2017-1-EL-EPPKA2-SSA
Project Acronym:	SEnDIng
Project Title:	Sector Skills Alliance for the design and delivery of innovative VET programmes to Data Science and Internet of Things professionals

Title of Deliverable:	Recommendations for validation, certification & accreditation of provided VET programmes
Work package:	WP4 "Implementation of skills certification mechanism"
Task:	4.1 Recommendations for validation, certification & accreditation of provided VET programmes
Document identifier:	SEnDIng_DLV4.1-final
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Delivery Slip

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PROJECT SUMMARY

SEnDIng project aims to address the skills' gap of Data Scientists and Internet of Things engineers that has been identified at the ICT and other sectors (e.g. banking and energy) at which Data Science and Internet of Things have broad applications. To achieve this goal, SEnDIng will develop and deliver to the two aforementioned ICT-related occupational profiles two learning outcome-oriented modular VET programmes using innovative teaching and training delivery methodologies.

Each VET programme will be provided to employed ICT professionals into three phases that include: (a) 100 hours of on-line asynchronous training, (b) 20 hours of face-to-face training and (c) 4 months of work-based learning. A certification mechanism will be designed and used for the certification of the skills provided to the trainees of the two vocational programmes, while recommendations will be outlined for validation, certification & accreditation of provided VET programmes.

Furthermore, SEnDIng will define a reference model for the vocational skills, e-competences and qualifications of the targeted occupational profiles that will be compliant with the European e-Competence Framework (eCF) and the ESCO IT occupations, ensuring transparency, comparability and transferability between European countries.

Various dissemination activities will be performed –including the organisation of one workshop at Greece, Bulgaria and Cyprus and one additional conference at Greece at the last month of the project– in order to effectively disseminate project's activities and outcomes to the target groups and all stakeholders. Finally, a set of exploitation tools will be developed, giving guides to stakeholders and especially companies and VET providers, on how they can exploit project's results.

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1 Introduction

1.1 Scope and objectives

The scope and main objectives of the deliverable are the following:

- To present the National Qualifications Framework of the countries which participate in the delivery of the developed SEnDIng training programmes on Data Science and Internet of Things.

- To describe the ECVET principles and applications, along with the degree of adoption in Greece, Bulgaria and Cyprus.

- To present similar to SEnDIng VET programmes which are delivered at partners' country level.

- To break down the two VET programmes developed under SEnDIng based on the ECVET logic and allocate the appropriate credits per Unit, based on the learning outcomes and the teaching methods identified at the deliverable "WP2: Learning outcomes identification and design of vocational curricula/educational modules and training/ assessment methodology".

1.2 Audience of the document

The audience interested to this deliverable is a) the SEnDIng project partners, b) ICT companies and professionals participating in the work-based learning phase of the VET programmes and c) competent institutions such as qualification authorities, awarding bodies, certification bodies or HEIs and VET providers.

1.3 Acronyms

Cedefop	European Centre for the Development of Vocational Training
ECVET	European Credit system for Vocational Education and Training (credit system)
ECTS	European Credit Transfer and accumulation System
E.O.P.P.E.P.	National Organisation for the Certification of Qualifications and Vocational Guidance
EQF	European Qualifications Framework
NQF	National Qualifications Framework
EU	European Union
HQF	Hellenic Qualification Framework
CyQF	Cypriot Qualification Framework

BQF	Bulgarian Qualification Framework
VET	Vocational Education and Training
IVET	Initial Vocational Education and Training
CVET	Continuing Vocational Education and Training
DS	Data Science
IoT	Internet of Things
EOPPEP	National Organization for the Certification of Qualifications and Vocational Guidance (Greece)

1.4 Dependencies with other WPs and deliverables

This deliverable is directly connected to the following deliverables within WP2:

- D2.1: Learning Outcomes in terms of knowledge, skills and competences

- D2.2: Reference model of skills, e-competences and qualifications needs of Data Scientists and IoT Engineers

- D2.3: Vocational curricula/educational modules for Data Science and Internet of Things VET programmes

- D2.4: Training methodology

- D2.5: Training monitoring and assessment methodology

The deliverable also complies with the requirements provided by the current versions (at the time of editing this deliverable) of SEnDIng Quality Assurance Plan and Impact Evaluation Methodology.

2 Qualifications Frameworks and ECVET in Greece, Bulgaria and Cyprus

2.1 Hellenic Qualifications Framework (HQF)

In Greece, a classification system is developed for qualifications acquired through non-formal education and informal learning, the Hellenic Qualifications Framework (HQF), which facilitates transparency and comparability in the Greek context. Its referencing to the European Qualifications Framework provides a tool for "translating" and comparing qualifications and aims at becoming an opportunity to help the promotion of the mobility of learners and employees. The National Organisation for the Certification of Qualifications and Vocational Guidance (E.O.P.P.E.P.) is responsible for developing the Hellenic Qualifications Framework and for referencing it to the European Qualifications Framework, under the supervision and coordination of the Ministry of Education and Religious Affairs. Regarding the Initial Vocational Training, EOPPEP is responsible for the examination and certification of students having completed training at Initial Vocational Training Institutions (SEK-Level 3 and IEK-Level 5).

Table 1: The eight levels of the Hellenic Qualifications Framework

Levels	IVET	General Education	Higher Education
1		Elementary (Primary) School certificate	
2		Lower Secondary School certificate	
3	• Vocational Training School (SEK) 'degree'* (post lower secondary level) • Vocational Training Institute (IEK) certificate** (post lower secondary level)		
4	• Vocational School (EPAS) certificate • Vocational Upper Secondary School (EPAL) 'degree'* (level 4) • Vocational Upper Secondary School (EPAL) certificate	General Upper Secondary School certificate	
5	• Vocational Upper Secondary School 'degree'* (apprenticeship class) • Vocational Training Institute (IEK) diploma (issued to graduates after certification) • Post-secondary and not higher education diploma/'degree'*		
6			Bachelor's degree
7			Master's degree
8			Doctorate

* It should be noted that the word 'degree' whenever used within quotation marks, it signifies that it is a direct translation from the terminology in Greek as it appears in the Greek legislation (ptychio). In Greek, the word ptychio is used for titles of study from different education levels (higher, secondary etc). It is by no means to be confused with its usage in the English language, whereby the word degree refers to higher education title of study, i.e., Bachelor's degree

** This qualification is no longer awarded since the enactment of the Law 4186/2013

Architectural structure of the HQF

The architectural structure of the HQF considers the current national needs and European ones, covering the entire range (8 levels) of qualifications, beginning from the compulsory education to the higher one (see Table 1). Each level is defined by descriptions of the knowledge, skills and competence which determine the learning outcomes for this level.

Referencing of the HQF to the EQF

- On January 24, 2014 there was held in Cedefop a Consultation Meeting on the HQF and its referencing to EQF with the social partners and major stakeholders, and also the fourth meeting of the Referencing Committee.

- On February 27, 2014, the Referencing Report of the HQF to the EQF was presented at the 23rd Meeting of the EQF AG in Birmingham, United Kingdom.

- On March 31, 2014, at the 24th Meeting of the EQF AG in Leuven, Belgium, EOPPEP presented the answers to the remarks made by the AG and the Referencing Report of the HQF to the EQF.

- By the Law 4283/2014, the classification of the following qualifications was legislated:

Vocational Training School (SEK) – Specialty certificate	Level 3
Vocational School (EPAS) certificate	Level 4
Vocational Upper Secondary School (EPAL) certificate	Level 4
Vocational Upper Secondary School (EPAL) 'degree'	Level 4
Vocational Upper Secondary School (EPAL) 'degree' and apprenticeship class	Level 5
Vocational Training Institute (IEK) (specialty) diploma	Level 5

VET provision in Greece[1]

Vocational education and training in Greece is strongly state-regulated and, until recently, mostly offered through a school-based approach. Overall responsibility is with the Ministry of Education and Religious Affairs, in cooperation with the Ministry of Labour and Social Affairs. There are two main routes at upper secondary level: general education and VET. Both lead to an equivalent upper secondary school leaving certificate at EQF level 4. On completion of the first year, learners are allowed to change direction from general to vocational education and vice versa.

The main VET route goes through three-year vocational programmes at Epaggelmatiko Lykeio school (EPAL) that also lead to a specialisation degree. EPAL schools have over 25% of work-based learning (WBL). According to the 2016 reform, these programmes consist of:

- first year: common for all learners (general education);

- second year: learners choose among nine sectors, with topics such as health and social care, mechanical engineering;

- third year: specialisation year.

EPAL graduates can take part in a designated national examination for admission to tertiary education programmes that correspond to their specialisation. The number of available places is governed by a quota system. EPAL programmes are also offered to employed people with lower secondary education, at evening classes lasting four years.

Adults who graduated from a general education programme at Geniko Lykeio school (GEL) are entitled to enrol in VET, in the second year of EPAL.

Two-year apprenticeship programmes (EPAS) are also available at upper secondary level. They are open to young people, 16 to 23 years old, who have completed at least the first year of upper secondary education. These programmes have more than 80% of work-based learning and lead to specialisation degrees at EQF level 4. EPAS graduates can continue their education in post-secondary VET programmes.

At post-secondary level, VET is offered in two formats:

(a) one-year apprenticeship programmes (EQF level 5, work-based learning 100%) introduced in 2016, offered by the local EPAS in cooperation with the Manpower Employment Organisation. This programme is offered only for people who hold an upper secondary school leaving certificate and an EPAL specialisation degree.

(b) two and half-year post-secondary VET programmes (work-based learning >20%) offered by public and private vocational training providers (IEK) to upper secondary graduates. These programmes allow learners to get just an attestation of programme

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[1] https://www.cedefop.europa.eu/files/8124_en.pdf

completion. Alternatively, they can take vocational training certification examinations (practical and theoretical) conducted by the National Organisation for the Certification of Qualifications and Vocational Guidance (EOPPEP) leading to a post-secondary VET certificate (EQF/NQF level 5). EPAL graduates, who continue their studies in a related field, can enrol in the second year directly.

Two to four-year higher professional programmes are offered by higher professional schools, under the supervision of the competent ministry. Admission is granted via general national examinations or a programme-specific admission examination. The diplomas awarded can be either equivalent to higher technological education diplomas (EQF level 6) in the case of merchant navy academies, or are considered non-university tertiary level diplomas (EQF level 5) for example, dance and theatre schools.

Continuing vocational training is offered to adults in centres for lifelong learning run by regional authorities, municipalities, social partners, chambers of commerce, professional associations, higher education institutions and private entities. EOPPEP is responsible for quality assuring non-formal education, accrediting providers and certifying qualifications for graduates in accordance with relevant provisions.

Greek society strongly favours general education and appreciates university studies. Both these factors reflect sociological stereotypes rooted in long-lasting perceptions and have affected overall VET attractiveness. VET has been characterised by higher dropout rates, multiplicity and complexity of the legal framework, challenges regarding the design and implementation of VET-related policies and impediments to linking with the labour market. It remains a second choice and often attracts low performers, who may also come from lower economic backgrounds.

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Figure 1: VET in the Greek education and training system
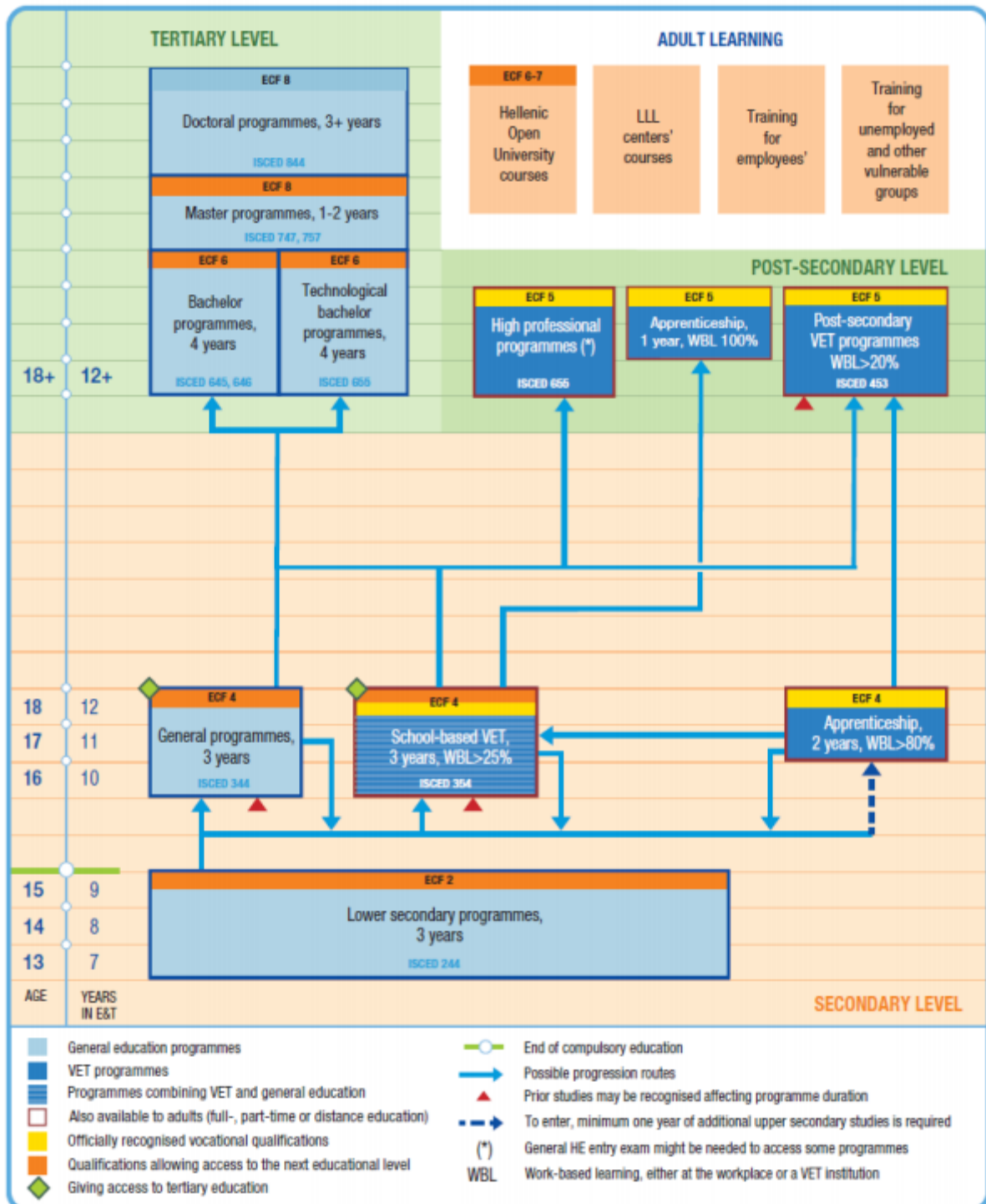
2.2 Bulgarian Qualifications Framework (BQF)

The National Qualifications Framework of Bulgaria (BQF) covers the entire education system and all qualifications. It defines nine levels, including level 0 (preparatory). Upper secondary and post-secondary (college) VET qualifications refer to NQF levels 2-5. Levels 6-8 relate to qualifications obtained in higher education degrees: 'bachelor', 'master' and 'doctor'. Higher education levels are also linked to the Framework for Qualifications of the European Higher Education Area.

The Education Minister is the competent authority for maintaining and updating the BQF (with decision of the government). BQF is published on the website of the Ministry of Education and science[2]:

(a) **BQF Level 0** labelled as a preparatory level refers to pre-primary education. This level corresponds to ISCED-P 020.

(b) **BQF Level 1** refers to the primary stage of basic general education, i.e., from grades I to IV. This level corresponds to the **EQF level 1** and ISCEDP 100.

(c) **BQF Level 2** applies to (lower secondary) education in general education and for the VET qualification level 1. This level corresponds to the **EQF level 2** and ISCED-P 244 and 351.

(d) **BQF Level 3** refers to the second level of proficiency. This level corresponds to the **EQF level 3** and ISCED-P 351 and 354.

(e) **BQF Level 4** applies to secondary education in general education and third level of proficiency. This level corresponds to the **EQF level 4** and ISCED-P 354.

(f) **BQF Level 5** refers to the fourth level of proficiency. This level corresponds to **level 5 of the EQF** and ISCED-P 453.

(g) **BQF level 6** is divided into two levels:

    1. sublevel 6A applies to professional bachelor (180 credit ECTS). This subsection corresponds to **level 6 of the EQF** and ISCED-P655;

    2. sublevel 6B applies to bachelor (240 credit ECTS). This subsection corresponds to **level 6 of the EQF** and ISCED-P 645.

(h) **BQF level 7** includes:

    1. Master's after 'Professional Bachelor in ...' in the same professional field (120 credit ECTS). This subsection corresponds to the **EQF level 7** and ISCED-P 767;

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[2] http://www.mon.bg/?h=downloadFile&fileId=1980

2. Master's after bachelor's degree (60 credit ECTS). This subsection corresponds to the **EQF level 7** and ISCED-P 767;

3. Master's after Bachelor's in different field (120 credit ECTS). This subsection corresponds to the **EQF level 7** and ISCED-P 767;

4. Master's degree, which provides specific training only in that field (300 credit ECTS). This subsection corresponds to the **EQF level 7** and ISCED-P 766.

(i) BQF level 8 includes the Doctor's Degree and corresponds to **EQF level 8**.

Level 'zero' is a preparatory level of pre-school education before first grade. It has no corresponding level in the EQF but is included in the BQF to encompass the entire education system.

VET provision in Bulgaria

School VET is provided only at a secondary level. Until August 2016, the lowest level of qualification could also be acquired in lower secondary education programmes. Out-of-school adults (16+) can still acquire the lowest VET qualification level (VET qualification level 1, BQF/EQF level 2) before secondary education. The Upper secondary VET aims at obtaining a vocational qualification but also comprises a general education part that is required to acquire secondary education. VET complies with the requirements of the state educational standards and consists of theory and (study and production) practice. The study practice is conducted during the learning process and is performed mostly in schools. The production practice usually takes place at the end of 11 and 12 grade in a real work environment. VET may also be organised as work-based learning (dual training system).

Schools providing VET are vocational gymnasiums, art schools and sports schools. Other providers (profiled gymnasiums, secondary schools, prison's schools) may also provide VET in separate classes. Examples of qualifications at upper secondary level are builder, electro technician, electronic equipment technician, cook, waiter, assistant trainer in sports and system programmer. Upper secondary VET is completed with State matriculation examinations in 'Bulgarian language and literature' and a State qualification examination. Graduates receive a secondary education diploma (BQF/EQF level 4) and a certificate of vocational qualification (BQF/EQF levels 3 or 4). The acquired vocational qualification gives access to the labour market. Students, who are willing to continue their education, can enrol in higher education institutions (universities, research universities, specialised higher schools or independent colleges).

VET can start quite early (at the age of 13) and is spread over four levels in the BQF (levels 2 to 5), starting with the 'first level' of a vocational qualification placed at level 2, along with the basic education certificate. Levels 3 and 4 comprise lower and upper secondary stages and include the 'second and third level' of a vocational qualification, along with general education. Level 5 comprises VET only; the 'fourth level' of a vocational

qualification is placed here. This is the most advanced (post-secondary) vocational qualification. Levels 6-8 relate to qualifications obtained in higher education – bachelor, master and doctor degrees. Each level corresponds to the relevant level of the EQF.

Figure 2: VET in the Bulgarian education and training system
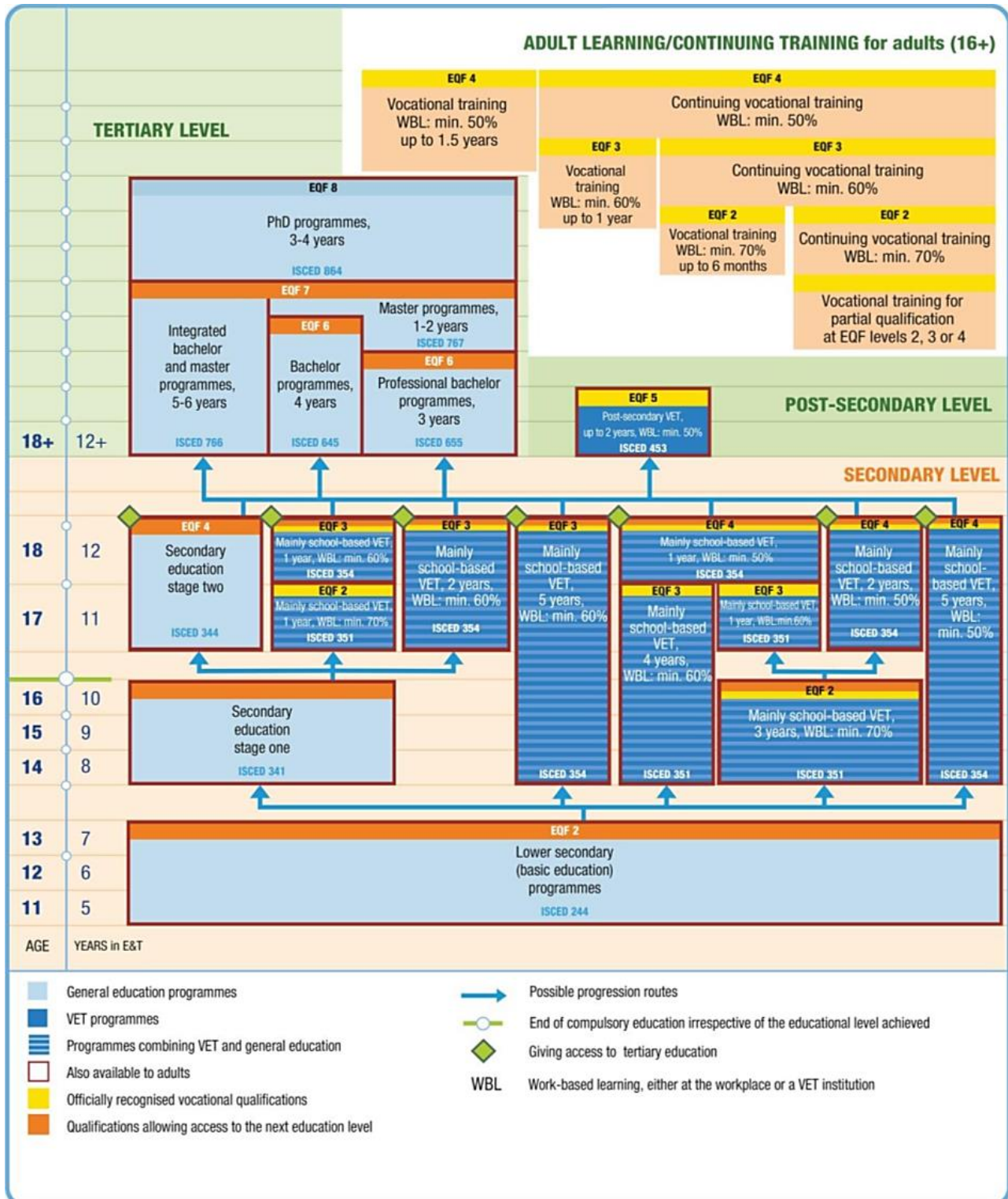
2.3 Cypriot Qualifications Framework (CyQF)

CyQF includes all levels and types of qualifications from all subsystems of education and training, from primary to higher education qualifications.

The methodologies used are:

- Setting common standards of CyQF and EQF through Level Descriptors

- An eight-level reference structure is adopted and all Level Descriptors are based on learning outcomes

- All Level Descriptors are generic in order to have a neutral point of reference that can be applied on all forms of education (formal/informal/non-formal as well as to all sectoral qualifications)

- The Level Descriptors are more detailed than the EQF descriptors. This makes them more user friendly

- They were simultaneously formulated for all levels so there would be clear progression from one level to the next.

Table 2: The Cyprus Qualifications Framework

Levels	Educational/Academic Qualifications		Occupational/ Vocational Qualifications	EQF Levels
1	Compulsory Education Certificate (Elementary School Leaving Certificate, and/or graduates of 7th and/or 8th Class)			1
2	Compulsory lower secondary education certificate 9th Class	Preparatory Programme (New Modern Apprenticeship)		2
3	Lower Secondary Education Certificate 10th Class	New Modern Apprenticeship Certificate	SVQ Level* 3	3
4	Upper Secondary General Education and Evening School Certificates (12th Class-or 12th & 13th for some private schools)	Upper Secondary Technical and Vocational Education and Evening Technical School Certificates (12th Class)	SVQ Level 4	4
5	Post-Secondary Certificates and Diplomas (1 year)		SVQ Level 5	5
	Post-Secondary Certificates and Diplomas (2 years)			
	Higher Certificates and Diplomas (3 years or more)			
6	University Degree (Ptychion/Bachelor's Degree)		SVQ Level 6	6

7	Post Graduate Certificates		**7**
	Post-Graduate Diploma		
	Master's Degree		
8	Doctoral Degree		**8**

* SVQ Level: System of Vocational Qualifications

VET in Cyprus

Over the last decades, technical and vocational education in Cyprus has gone through several stages and has been called upon to assume various roles, depending on the socio-economic situation and the tendencies prevailing in industry and the labour market. In this multifaceted, continually changing environment, technical and vocational education should not be viewed as a simple, static process of amassing knowledge and skills. Rather, it should be regarded as a continuous economic and social necessity, capable of providing equal opportunities to all and, thus, operating as a mechanism that combats social exclusion and promotes social cohesion.

Bearing these in mind, the general objectives of technical and vocational education in Cyprus are to:

- help society achieve its goals for social, cultural and economic growth.

- contribute to the improvement of the quality of life, by providing individuals with the opportunity to broaden their intellectual horizons.

- enable society to utilise the fruits of economic and scientific-technological changes, for the benefit and prosperity of society as a whole.

- offer pupils solid knowledge and broad technological training, making technical and vocational education an attractive option for the development of their talents, interests and skills, therefore leading them either towards tertiary education or the world of work.

- enhance understanding of technological dimensions in modern civilisation and their impact on the environment.

- develop the decision-making competencies of pupils, as well as the necessary attitudes for active and educated participation, co-operation and leadership at the place of work and in society in general.

Formal mainstream upper secondary initial technical and vocational education programmes are offered free of charge in two directions, the theoretical and the practical direction. The duration of studies is three years for each direction. The first year of studies is common for each direction and field of study, and pupils select a specialisation offered in their

chosen field of study in the second and third year of their studies. The theoretical direction and the first and second years of the practical direction are completely school-based and combine general education subjects with technological and workshop subjects. The third year of studies in the practical direction combines a school-based environment with a real workplace, as final-year pupils are placed in industry for one day per week, where they follow a practical training programme.

Upon completion of secondary technical and vocational education, pupils receive a leaving certificate, which is equivalent to that awarded by lyceum (secondary general education schools), providing access to the world of work or to Institutions of Higher and Tertiary Education in Cyprus or abroad, as indicated in the figure below.

Figure 3: The main pathways within formal upper secondary technical and vocational education

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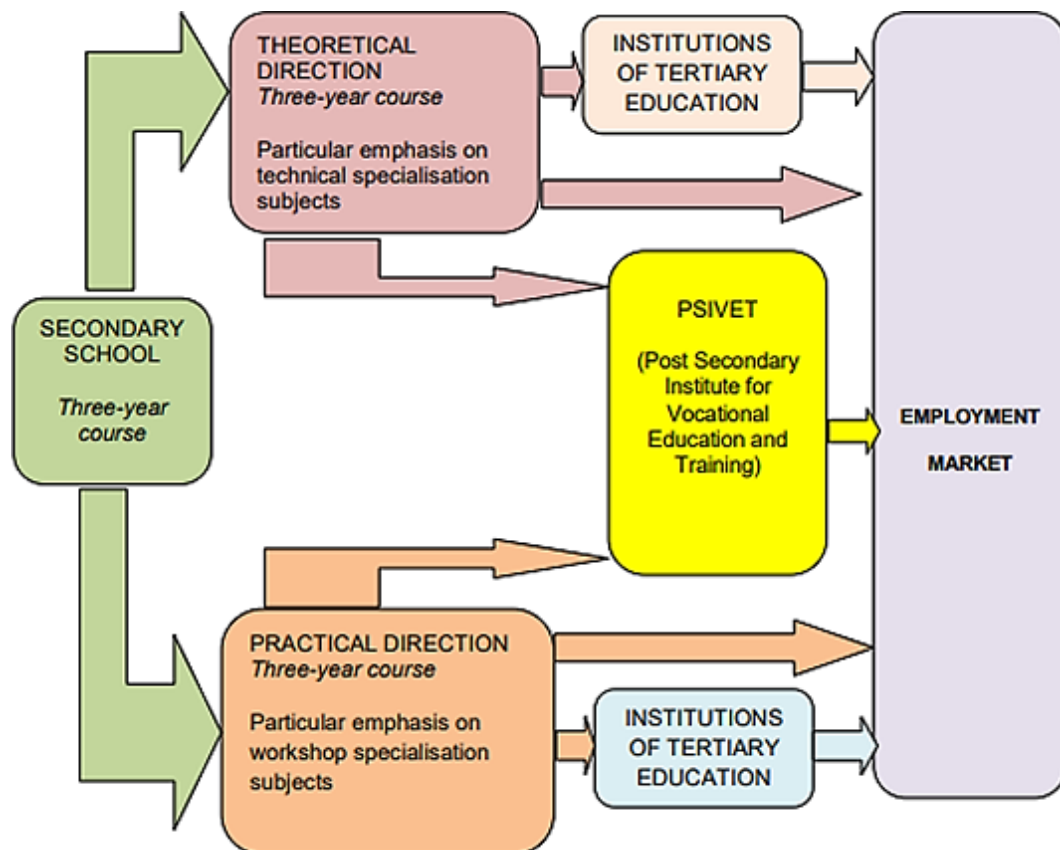
Figure 4: VET in the Cypriot education and training system
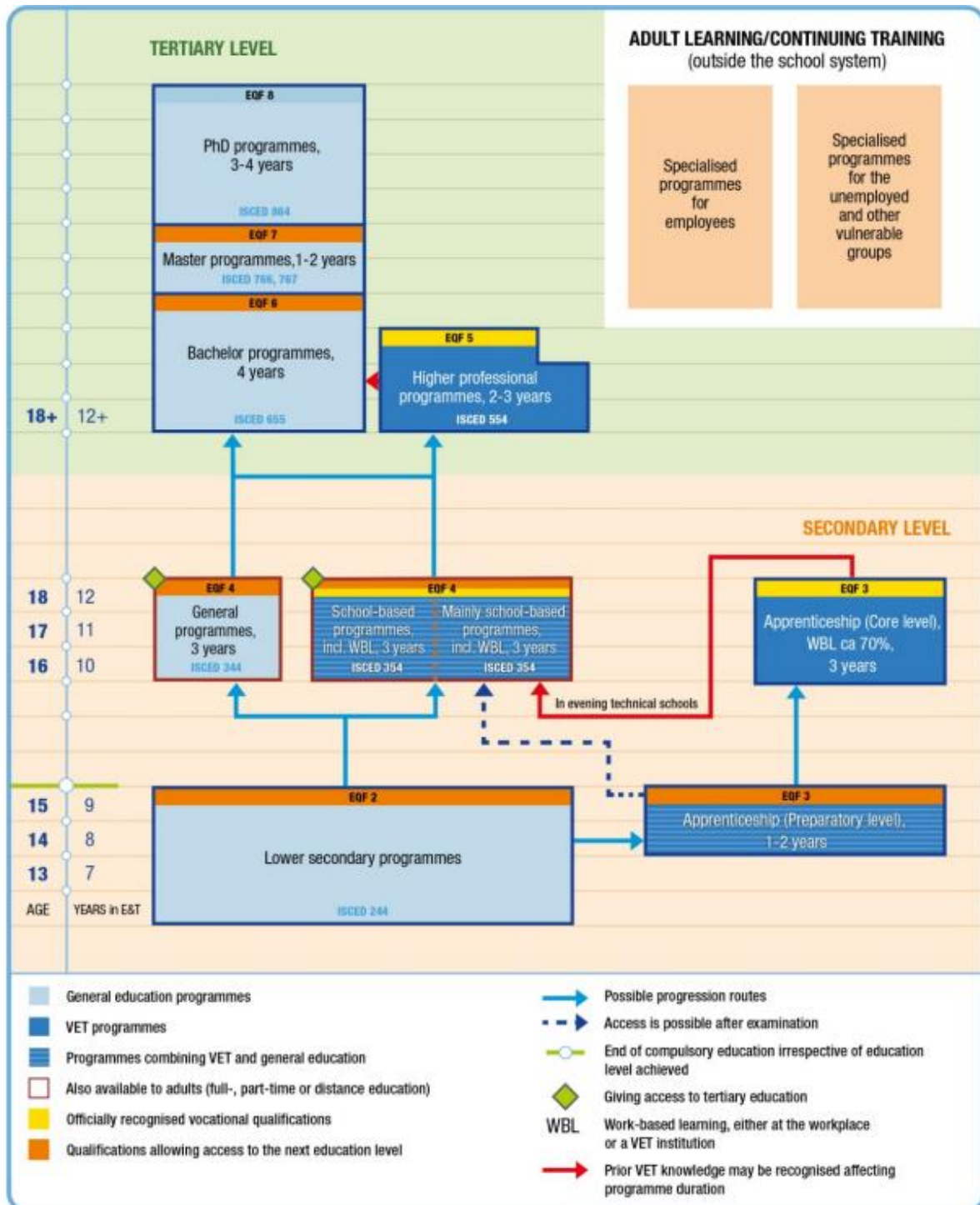
2.4 ECVET

2.4.1   Understanding the ECVET principles

The European Credit system for Vocational Education and Training, often referred to as ECVET, is a technical framework for the transfer, recognition and (where appropriate) accumulation of individuals' learning outcomes with a view to achieving a qualification. Guided by a European-level Recommendation, ECVET relies on the description of qualifications in units of learning outcomes, on transfer, recognition and accumulation processes and on a series of complementary documents such as a Memorandum of Understanding and Learning Agreement.

ECVET is intended to facilitate the recognition of learning outcomes in accordance with national legislation, in the framework of mobility, for the purpose of achieving a qualification. ECVET aims to support the mobility of European citizens, facilitating lifelong learning –achieved in formal, non-formal and informal settings– and providing greater transparency in relation to individual learning experiences, making it more attractive to move between different countries and different learning environments.

At a systems level, ECVET aims towards greater compatibility between the different vocational education and training systems in place across Europe, and their qualifications. From a geographical mobility perspective, ECVET aims at facilitating the validation, recognition and accumulation of knowledge and skills acquired during a stay in another country, with a view to ensuring that such achievements can contribute to the achievement of vocational qualifications.

2.4.2   Basic elements of ECVET

As it was stated, ECVET is a technical framework for the transfer, recognition and, where appropriate, accumulation of learning outcomes with a view to achieving a qualification.

Qualification *means a formal outcome of an assessment and validation process which is obtained when a competent institution determines that an individual has achieved learning outcomes to given standards.*

The ECVET tools and methodology consists of:

- the description of qualifications in terms of units of learning outcomes with associated points,

- a transfer and accumulation process, and

- complementary documents (e.g., learning agreements and transcripts of records).

Figure 3 presents the ECVET objectives, basic elements and technical components together with their association.

Figure 5: ECVET objectives and technical components
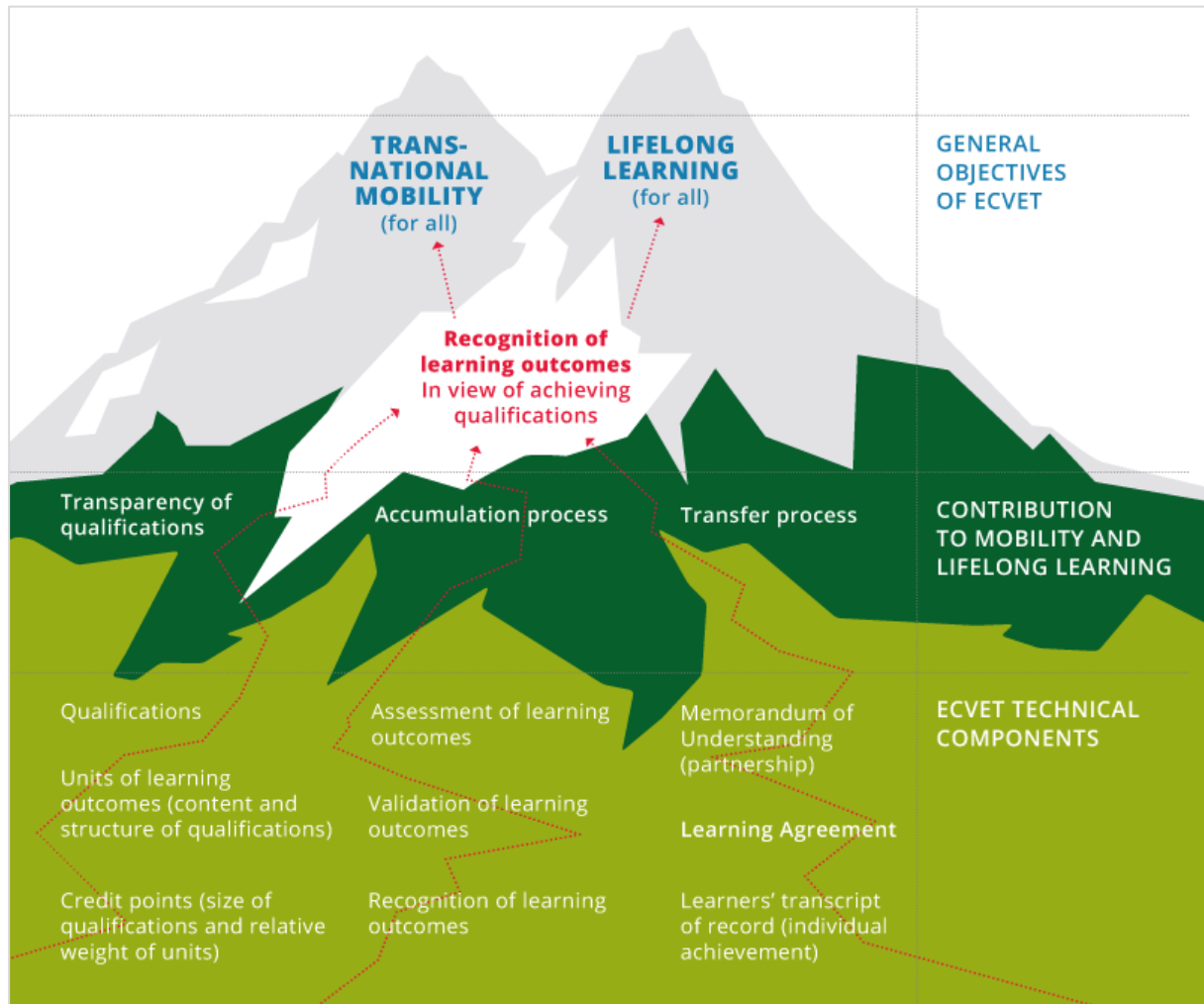
Source: Adapted from ECVET Toolkit, 2019

2.4.3 Learning Outcomes

Learning Outcomes (LOs) are defined in the Recommendation of the European Parliament and of the Council on the establishment of the EQF, and in a similar ECVET Recommendation, as "statements of what a learner knows, understands and is able to do on completion of a learning process, and which are defined in terms of knowledge, skills and competence". Learning outcomes are usually developed as a part of the process of designing and building qualifications, and can be achieved, by individual learners, through various different learning pathways, modes of delivery and learning contexts (formal, non-formal and informal).

Learning outcomes can be used for various purposes such as to establish descriptors of qualification frameworks, define qualifications, design curricula, assessment etc. They are set out in various levels of detail depending on their purpose and context. There are different approaches to identify and describe learning outcomes depending on the

qualifications system. Learning outcomes may be acquired through a variety of learning pathways, modes of delivery (school-based, in-company, workplaces etc.) in different learning contexts (formal, non-formal and informal) or settings (i.e., country, education and training system etc.)

Table 3: Descriptors defining levels in the European Qualifications Framework (EQF)

Level	Knowledge	Skills	Competences
4	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change Supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change Review and develop performance of self and others

The use of learning outcomes changes the focus of a VET programme, from the learning objectives to the learning outcomes. It refers to a set of structured learning activities, contents and/or methods implemented to achieve specific and stated learning objectives and leading to a certification and after assessment to a qualification. Learning objectives express the intention of teachers, for example, they are related to the specific content the teacher intends to deliver. On the other hand, learning outcomes are always described from the learners' viewpoint rather than from the teachers' viewpoint. With the introduction of EQF and ECVET instruments, learning outcomes have been gradually introduced to all Member States, as a prerequisite for the transparency of qualifications.

2.4.4   Unit of Learning Outcomes

A **Unit of Learning Outcomes** is a component of qualification, consisting of a coherent set of knowledge, skills and competences that can be assessed and validated autonomously. The units that make up a qualification are[3]:

- **clearly understood** by involved actors –such as learners, teachers and trainers (in the home and host institutions) and competent institutions with responsibility

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[3] http://www.ecvet-toolkit.eu/ecvet-toolkit/identify-units-learning-outcomes

for validating and recognising learning outcomes achieved during a period of geographical mobility;

- **achieved during mobility** –for example, taking into account the existing knowledge, skills and competence of learners, the duration of the planned mobility and the learning opportunities able to be accessed in the host institution and country;

- **assessed abroad** –some learning outcomes may be easier to assess abroad than others and it is also important to consider the language skills of individual learners;

- **recognised** when the learner returns to the home institution.

The expected learning outcomes defining a unit may be achieved irrespective of where or how these have been achieved. Thus, a unit is not to be confused with a component of a formal learning programme or training provision.

2.4.5   Validation and Recognition[4]

To ensure that learning outcomes achieved abroad can be integrated into an individual learner's qualification or pathway, involved partners –in particular the competent body that is responsible for awarding the respective qualification– must clarify the following aspects:

- How will the validation and recognition of learning (and, in some cases, credit) achieved abroad be carried out and recorded?

- Who is responsible for each step in this process both in the home system and the home organisation (note that in some cases these might not be the same body)?

- What are the practical consequences of validation and recognition? For example, will the learner receive a certificate or personal transcript? If the learner is participating in a VET programme in which grades are used, how will grades will be awarded for learning outcomes achieved abroad?

Depending on the systems in place, validation and recognition might form two separate steps or be combined in a single action. The **validation of learning outcomes** is generally understood to mean the process of confirming that one or more learning outcomes that have been achieved (by a learner) and subsequently assessed (by the host institution) correspond to specific learning outcomes which may be required for a unit or a qualification. Validation is preceded by assessment and is based on the documentation of assessed learning outcomes by the involved assessor, recording this in a personal transcript (or similar) document. Those in charge of validation, in the home institution, then take stock of the initial assessor's judgement, comparing related documentation with the learning outcomes laid down in a document name learning agreement and examining the extent to which the two documents are consistent. If the expected learning outcomes are met at the

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[4] http://www.ecvet-toolkit.eu/ecvet-toolkit/clarify-validation-and-recognition

required level (proficiency, autonomy, etc.) then the assessment is normally validated meaning that learners can receive a pass or a specific grade.

The **recognition of learning outcomes** is generally understood to mean the process of attesting officially achieved learning outcomes through the award of units or qualifications. Following validation, learners receive official confirmation of the fact that the knowledge, skills and competence acquired abroad have been accepted as part of the intended qualification or as an add-on. In practice, this can mean that learners receive a certificate or that the unit(s) of learning outcomes are recorded in their personal transcript (or similar) document. Recognition can additionally entail that the individual or organisation in charge of recognition verifies that the processes of assessment and validation have taken place according to existing (national, institutional) rules and that there are no irregularities.

2.4.6   ECVET credits and ECVET points

Credits for learning outcomes includes a set of learning outcomes of an individual which have been assessed and can be accumulated towards a qualification or transferred to other training programmes or qualifications.

ECVET points provide complementary information about qualifications and units in numerical form. They have no value independent of the acquired learning outcomes for the particular qualification to which they refer, and they reflect the achievement and accumulation of units. To enable a common approach for the use of ECVET points, a convention is used according to which 60 points are allocated to the learning outcomes expected to be achieved in a year of formal full time VET[5]. According to that, the following diagram shows the way of assigning ECVET points to qualifications and units:
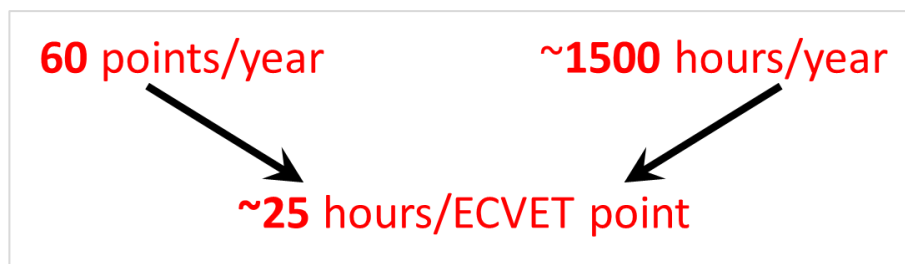
For a given qualification, formal learning context is taken as reference and based on the convention, the total number of points is assigned for that qualification. From this total, ECVET points are then allocated to each unit according to their relative weight within the qualification. For qualifications which do not have a formal learning pathway reference, ECVET credit points can be allocated through estimation by comparison with another qualification which has a formal reference context.

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[5] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2009:155:0011:0018:EN:PDF

To establish the comparability of the qualifications, the competent institution should refer to the equivalent EQF level or, possibly, NQF level, or to the similarity of the learning outcomes in a closely related professional field.

For the calculation of the **relative weight** of a unit of learning outcomes, different criteria can apply:

- the **relative importance** of the learning outcomes which constitute the unit for labour market participation, for progression to other qualification levels or for social integration;

- the **complexity**, **scope** and **volume** of learning outcomes in the unit;

- the **effort necessary** for a learner to acquire the knowledge, skills and competence required for the unit.

Figure 6: Allocation of ECVET points across a training programme/qualification
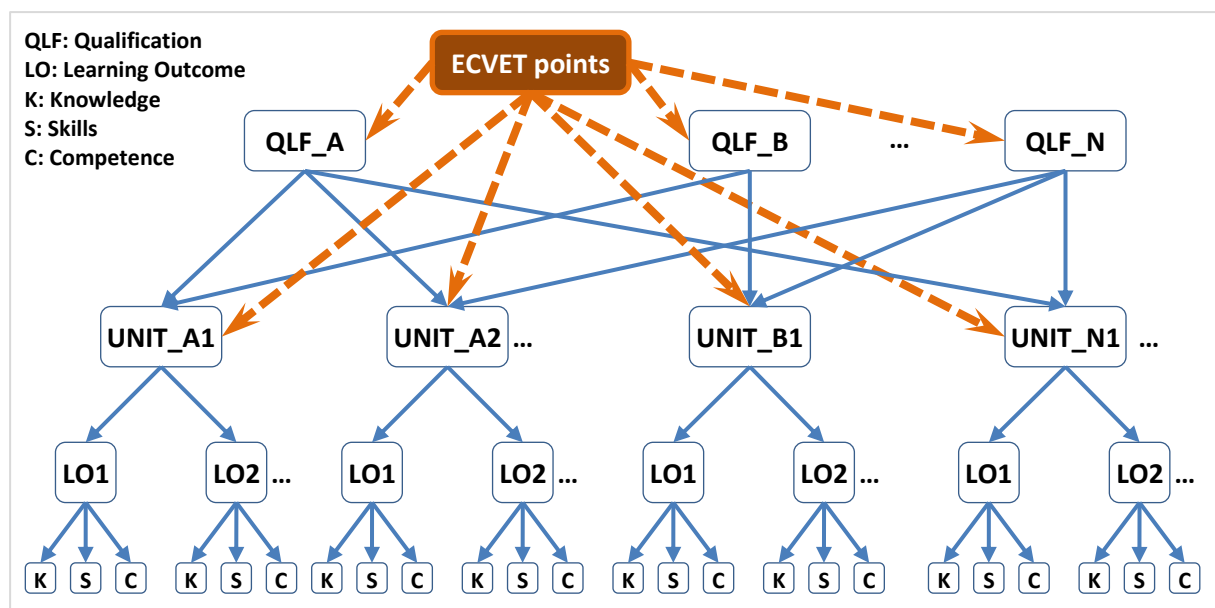
2.5 ECVET adoption and implementation in the participating countries

Based on the fact that the EU does not intervene directly in the internal national processes for design and implementation of education and VET systems of its Member States and does not demand in a restrictive manner the implementation of education policy measures, the adoption of the general directives and subsequent common tools is a responsibility and choice of each Member State. It is therefore established that in the context of an Open Method of Coordination the Member States have all the necessary autonomy for the development of the appropriate procedures to ensure the success of active policies which will lead to the harmonisation across the EU.

As far as ECVET is concerned, it is the European Tool aimed to contribute to the enhancement of the employment mobility, through the evaluation of learning outcomes derived from vocational training, as well as non-formal and informal learning in the transparency, validity and reliability of results produced in the field of vocational education and training in the transfer of credit units (certifying the professional competence of employees) from one educational and work context on the other, both at national and European level, in assisting workers who wish to transfer their experience and competence into the European map of the modern labour market.

2.5.1 Greece

The development of ECVET is an important issue for Greece, since significant delays have been noticed when it comes to the modernisation and adoption of similar tools of innovation and integration in the European acquis. Moreover, the implementation of such an institutional reorganisation and reform agenda cannot in any way be the result of the work carried out by a closed group of experts or of a secluded network of organisations and institutions of the formal central bureaucratic structure. It requires broad and widespread political and social consent of all stakeholders involved, since the project at hand (i.e., the development of ECVET) is not only a technical issue. On the contrary, it is based upon the commonly approved and horizontal political belief that the European Union, as per the conclusions of the Lisbon treaty in 2000 will become in the future the most competitive economy in the international labour market, using as a vehicle knowledge and learning.

For Greece, EOPPEP is the main institutional structure, which has as principal objective the implementation of the National Qualifications Framework, which has been referenced to the EQF. In this context and in collaboration with all the social national and regional actors, EOPPEP is involved in all or some of the processes which are related to the ECVET implementation and in specific, its institutional involvement focuses on the development of standards and tools for the recognition and certification of qualifications, irrespectively of the learning path pursued, on issuing recommendations for the development of the relevant regulatory implementation framework and on the implementation of a unified certification system of knowledge, skills and competences.

At the same time, it is clear that in the case of Greece the ECVET implementation cannot be seen irrespectively of the broader institutional adjustments. Therefore, the development of the Hellenic Qualifications Framework is the most important element for the promotion of the ECVET for VET provision and will determine the future of its successful implementation. In this respect, EOPPEP has so far initiated actions and initiatives that, despite the significant delays noticed in the country, are gradually opening the way to maturing the processes of implementation and adoption of decisive developments.

2.5.2   Bulgaria

In Bulgaria the Vocational Education and Training Act (VET Act 1999) regulates the organisation, management and financing of VET. In 2014 the reform and legislation changes supported the development of new State education standards, modernisation of VET systems and introduction of unit–based approach. This reform followed the idea of developing European mobility, improving recognition, validation and permeability within European education and training systems, each in line with the goals for ECVET implementation.

According to the Pre-school and School Education Act and the VET Act, acquisition of vocational qualifications is regulated by the State Educational Standards. The National Agency for VET designs the standards, in coordination with the relevant ministries and departments, and the Education Minister endorses them. The standards are structured by profession (often for multiple specialties) and include:

- requirements for the candidates.

- description of the profession.

- units of learning outcomes.

- requirements for training facilities.

- requirements for trainers.

This approach has used the principles of the ECVET recommendation since 2015. It aims at linking units of learning outcomes with credits in VET. The standards are mandatory for VET programmes leading to nationally recognised qualifications, including for adults.

2.5.3   Cyprus

A working committee on ECVET development and implementation in Cyprus was set up in September 2011. It comprises of stakeholders from the public and the private sectors, such as the Ministry of Education and Culture, the Ministry of Labour and Social Insurance, the Planning Bureau, the Human Resources Development Authority, the Cyprus Productivity Centre, the Foundation for the management of the European lifelong learning programmes in Cyprus and private providers of VET.

In Cyprus, ECVET is not yet in place. In accordance with a recent presentation made by the Ministry of Education and Culture of Cyprus (Ministry of Education and Culture, 2015) the current situation is summarised as follows:

- The IVET system in Cyprus is mainly input-oriented (length of education and training programmes, quality of teachers) and does not utilise units or modules to qualifications or training programmes.

- Certificates are awarded upon successful completion of a VET programme.

- Successful completion of the course is a prerequisite for the award of the state recognised certificate.

- Education and training providers validate achieved learning, while the responsible ministries and sectoral bodies validate and recognise it and issue the certificate.

- There are no situations of transfer of assessed learning between qualifications, or institutions.

In accordance with the same presentation (Ministry of Education and Culture, 2015), the priorities of the Ministry are to:

- finalise, reference and establish the NQF.

- develop outcome-based curricula.

- develop a mechanism for the validation of non-formal and informal learning.

In the last two years emphasis was placed on the training, preparation and professional development of the VET curriculum developers and teachers/trainers on competence-based curricula and assessment, development of the NQF and ECVET. As from September 2015, a group of 20 VET curriculum developers was formed, with the mission to develop new IVET curricula which would be based on competences, learning outcomes and ECVET recommendations.

It is noted that no information was found from desktop research regarding memorandum of understanding, learning agreement and ECVET points. Based on the above, one could conclude that the ECVET system is planned to be developed in Cyprus with some elements of it to exist in the case of Standards of Vocational Qualifications provided by the HRDA.

3 Data Science and IoT accredited VET programmes developed in Greece, Cyprus and Bulgaria

3.1 Greece

3.1.1 Data Science with Python

The distance learning VET programme "Data Science with Python" provided by the Centre for Continuing Education and Lifelong Learning of the National and Kapodistrian University of Athens (EKPA) is aligned with the ECVET system. The programme is accompanied with a Europass certificate supplement. Its duration is three months, along with 65 hours of practice. The units which comprise the programme provide a total of 6,5 credits based on the ECVET system. Upon successful completion of the programme, the learners are awarded a certificate of completion. The structure of the programme is provided in the following table.

Table 4: Data Science with Python-Programme Contents

Training Courses	Teaching Modules	ECVET points
Introduction to the Python Programming Language	1. Introduction to Python and its basics 2. Basic principles - Strings - Lists - Pleiades 3. Dictionaries - Flow control 4. Functions - Modules 5. Programmes - Archives - Exceptions	2,5
Python Applications in Data Science	1. Introduction to Data Science 2. Tools, techniques and technologies for Data science 3. Python Environment for Data Science 4. Recovery, collection, cleaning, data management 5. Descriptive statistics and data visualisation	2,5
Python Applications and Large Data (Big Data)	1. Introduction to Big Data 2. Python programming for large scale data 3. Python programming for data analysis from Social Networks	1,5

The programme is addressed to professionals who wish to improve their knowledge in the topic, Higher Education graduates who wish to specialise in the field and be in the position to be employed as data scientists, as well as trainers who wish to attend a state-of-the-art programme in the field.

After the completion of the programme, the participants will be in the position to:

- perform descriptive analytics;
- calculate different statistical measures and indicate the correlations among different variables;
- get acquainted with popular Machine Learning and Deep Learning packages which are available for Python, such as Scikit Learn, Tensorflow and Keras;
- conduct predictive analytics with the use of algorithms.

3.1.2 Business Analytics & Big Data

The Athens University of Economics and Business (AUEB) offers an annual specialisation programme on Business Analytics and Big Data, with an overall duration of 250 hours, followed by an internship or dissertation. It is designed for business executives who wish to acquire practical skills in the specific field. The requirements for attendance are to have a technological background (i.e., IT & engineers), science (mathematics, physics, statistics), business administration and any other field taking into consideration relevant technical training of the candidate. The objective of the programme is to present the basic theoretical principles in business analytics and big data and to train them in systems, tools and programming languages which are used. It should be highlighted that the programme puts much emphasis on the presentation of case studies on applications of business analytics.

The delivery of the programme is through face-to-face sessions, twice a week.

Through the participation in the programme, the learners will acquire skills on:

- Business targeting, standards and procedures;
- Management, collection and processing of data for their analysis;
- Development and implementation of analytical models;
- Interpretation and visualisation of the results of the analysis.

Based on these phases, the programme is structured into the following pillars:

- **Business Skills in Analytics** (33 hours): skills which relate to the design of business processes, legal knowledge related to privacy and data protection issues, innovation and entrepreneurship management.
- **Modern Data Management & BI** (57 hours): management of big data, business intelligence and big data, new big data management systems (Hadoop, NoSQL, Stream Engines), data integration.
- **Data Analysis & Tools** (102 hours): data analysis methods based on statistics and machine learning.

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- **Visualization** (30 hours): theoretical concepts of data visualisations and popular tools.

- **Case Studies** (24 hours): End-to-end analytics procedures across sectors (e.g. energy, telecom, banking, healthcare, transportation, finance, insurance, etc.) in order to facilitate the familiarise the participants with big data analysis.

Following the successful participation at the programme, all learners acquire a Certificate of Vocational Education and Training, in which the final score and their performance is also indicated.

3.1.3   Business Intelligence and Big Data Analysis

The Centre for Training and Lifelong Learning of the University of Thessaly provides the annual programme "Business Intelligence and Big Data Analysis", for which 600 training hours are provisioned. It focuses on the modelling and simulation of business performance, based on big data and business indicators, in order to create business development and operation scenarios, as well as future strategies. This field includes data mining, statistical and predictive analysis and database management systems with capabilities which go beyond the typical SQL based systems. Successful completion of this programme leads to an attendance certificate from the provider.

Table 5: Business Intelligence and Big Data Analysis-Programme Contents

Training Courses	Content
Blockchain technologies and decentralised applications	Introduction to the key elements of Blockchain technology and the general ecosystem surrounding it with particular emphasis on the corresponding applications known as decentralised applications
Introduction to Business Statistics and Finance	Methods of data analysis based on Statistics and Statistical Learning with emphasis on business and financial applications
Problem Solving Environments for Applications in Data Science	It introduces the R, SaS, Python, Spark, Weka, Rapid Miner, Apache Mahout, Oracle Data Mining environments and applies them to solve data access and mining problems
Large volume data management and analysis	Relational and NoSQL Databases. High volume data. Data Warehouses and Instant Analytics
Machine Learning for Data Analysis	Statistical machine learning techniques and large volumes of unstructured data for business analytics, sentiment analysis, and sentiment analysis are presented

Training Courses	Content
Basic principles of economics and business intelligence	An introduction to how business information technologies, combined with the basic principles of economics, can enhance decision-making in various business areas

The programme is addressed to Higher Education students or recent graduates who intend to follow a career path relevant to the data industry, as well as any person who wishes to change careers (mostly engineers, mathematicians, physicists, programmers and other IT professionals).

The programme is delivered through blended learning and includes:

- Face to face training sessions, delivered in the course of 6 weekends over 6 weeks.

- Synchronous e-learning sessions.

- Asynchronous e-learning sessions.

The programme provides:

- Online content and assignments on a weekly basis.

- Regular meetings with the trainers.

- Short tests.

- Dissertation and presentation.

- Three online tests across all units covered.

3.1.4   ReGeneration Academy for Digital Acceleration

The programme is an intensive hands-on training programme on basic and advanced Data Science principles developed by ReGeneration and TITAN, with Code.Hub as a training partner. The programme lasts 100 hours, it runs for six weeks and it includes two special training & coding all-day events, one of which will take place at the TITAN factory in Kamari, Viotia. During the programme, the participants will "unlock" up-to-date techniques and new tools for data collection, storage, transformation, use, visualisation and data acquisition, acquiring the skills needed to meet the growing demand for data scientists and hands-on scientists in data-related industry fields.

The programme is aimed at graduates at the beginning of their careers and focuses on one of the following academic directions:

- Computer Science, Computer Engineering, Programming;

- Mathematics, Statistics;

- Engineering, Applied Mathematics;

- Postgraduate programmes related to data science.

The core perspectives of this programme will be to present, explore and adequately cover with extended real-life business case studies & industry scenarios the following aspects:

- Python

- Data & Data Management Systems

- Big Data

- Data integration with Python

- Data analysis in Python

- Data Visualization

- Business Analytics (Descriptive, Predictive, Prescriptive)

- Dashboards & Visual Analytics

- Data Mining

- Machine Learning

- Artificial Intelligence.

3.1.5 Internet of Things (IoT) and Machine Learning Applications

The National and Kapodistrian University of Athens (EKPA) offers a short vocational programme on IoT and Machine Learning applications for Higher Education graduates, as well as secondary education graduates with professional experience in the field. The programme is offered through e-learning and its structure is provided in the table that follows.

Following the successful completion of the programme, the participants will know:

- IoT architecture, ad-hoc networks and sensor networks.

- Resources and tools for IoT applications development, including hardware and software requirements, as well as connectivity.

- Popular IoT applications.

- Cloud technology and IoT.

- Techniques and tools of machine learning in the implementation of smart applications.

- Basic principles of security and privacy in the Internet of the future.

Table 6: IoT and Machine Learning-Programme Contents

Training Courses	Content
Internet of Things architecture	• IoT architecture levels & Enabling Technologies • Ad-hoc networks and Sensor Networks • Cloud Overview • Security and privacy in the internet of the future
Introduction to the 4th Industrial Revolution	• The previous revolutions and the particularities of the 4th Industrial Revolution • Introduction to the 4th Industrial Revolution Technologies • Production Chain, automation and industrial production • Digital transformation and business strategies
IoT Applications	• Smart home • Smart cities • Smart industry and applications
Python & Machine learning	• Machine Learning & Deep Learning • Python • Libraries - Tensorflow & Keras • Machine learning algorithms

3.1.6 Embedded system design and microcontroller applications for the Internet of Things

The objective of this programme which is offered by the Hellenic Open University (HOU) is to cover the learning needs of graduates from Technical and IT Higher Education departments in digital systems design methodologies using sophisticated microelectronics technologies (Systems-on-Chip, Field Programmable Gate Arrays) and embedded systems.

Emphasis is put on the use of the aforementioned technologies for application development using modern microcontrollers and their respective design and development flows, especially in relation to sensor networks and the Internet of Things (IoT). Applications of interest focus on wireless communications in sensor network environments, an ever-evolving field requiring new techniques and protocols for successful communication, including but not limited to Interconnecting Wireless Sensor Networks, Automation Controller Networks, and other electronics and electronics management systems and their data.

Upon completion of the programme learners will have the laboratory experience to design systems using:

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- VHDL language and FPGA design flow (Intel Quartus, Cyclone IV).

- the configurable soft-core embedded Nios-II processor and its peripherals.

- the ARM Cortex M3 architecture and modern design tools.

- of the Arduino platform.

- the most widespread cloud services for sensor network applications and the Internet of Things (IoT).

Training provision will be based on the standard distance learning support methodology for hybrid forms. Development platforms will be used that will be distributed to trainees, and remote access infrastructure will be used in the laboratory structures of the HOU

Table 7: Embedded system design and microcontroller applications for the Internet of Things-Programme Contents

Training Courses	Content
Integrated System Design/ System on Chip Design Methodologies Using FPGAs	• VHDL hardware description language applications for hierarchical systems development • FPGA ALTERA QUARTUS / Nios-II EDK design flow • Architecture of synthetic microprocessors (ALTERA Nios-II, ZPUINO, openrisc) • Hierarchical design and integration of microprocessor interfaces peripherally integrated
Modern microcontroller architectures and programming	• Learning the ARM Cortex M3 architecture • ARM Cortex M3 programming and application development using development tools such as STM CubeMX IDE and system workbench • Application development and development on the Arduino IDE platform
Wireless Sensor Networks (WSN) and Internet of Things	• Wireless technologies and communication modules programming (RF / BT / BLE / 802.11 / 802.15.4) • Upper layer communication protocols (HTTP, CoAP, MQTT…) and IoT services (Xively, Thingspeak, dweet.io, freeboard.io)

3.1.7 Internet of Things

Provided by the University of Aegean, this VET programme is certified by the certification body Pearson Assured. It aims at presenting the basic elements of an Internet of Things system, as well as the application areas of such systems. In addition, the programme will analyse the reasons which led to the development of the IoT technology and the upcoming technological advancement.

By the end of the programme, the participants will understand:

- What an IoT system is and why it has been developed

- Which are its differences with other systems (such as wireless sensor networks)

- Which are the applications of an IoT system

- The communication protocols

- The design of an IoT system

The programme is designed for students and graduates of IT Higher Education departments who wish to acquire new knowledge and skills in a field of high demand from the labour market. The modules covered by the programme are:

- Introduction to IoT

- Architecture and Communication in the context of an IoT system

- Cloud IT and data processing

- Security and data integrity

The total duration of the programme is 32 hours over the course of one month.

3.2 Bulgaria

A desktop research on existing VET programmes in Bulgaria and curricula landscape on the topics of Data Science and Internet of Things implemented by ESI CEE, showed that there are no VET providers which plan, design or develop training programmes on those or related topics. There are three universities which provide Bachelor's and Master's programmes on similar topics:

- Varna Free University: Master programme in Data Science

- Sofia University "St. Kliment Ohridski": Master programmes in Embedded Systems, Mechatronics and robotics

- Technical University of Sofia: Master programmes in Embedded Systems for Management, Mechatronics, Big data analytics

3.3 Cyprus

After conducting an Internet research, we were not able to identify any VET programmes currently delivered in Cyprus related to Data Science and IoT.

3.4 Comparison of the identified VET programmes with SEnDIng VET programs

Following the identification of the similar VET programmes in Greece (given that no similar programmes were identified in Bulgaria or Cyprus), the consortium has made a comparison with the ones developed under the SEnDIng project, to check the degree to which they present similarities and the one to which they differ.

In the table that follows the breakdown of each programme is presented per provider.

Table 8: Comparison of already existing Data Science VET programmes with the one developed under the SEnDIng Project

EKPA	AUEB	University of Thessaly	ReGeneration Academy	SEnDIng
Introduction to the Python Programming Language	Business targeting, standards and procedures	Blockchain technologies and decentralised applications	Python	Introduction to Data Science
Python Applications in Data Science	Management, collection and processing of data for their analysis	Introduction to Business Statistics and Finance	Data & Data Management Systems	Python for Data Science
Python Applications and Large Data (Big Data)	Development and implementation of analytical models	Problem Solving Environments for Applications in Data Science	Big Data	Statistics for Data Science
	Interpretation and visualisation of the results of the analysis	Large volume data management and analysis	Data integration with Python	Storing and retrieving data
		Machine Learning for Data Analysis	Data analysis in Python	Applied machine learning
		Basic principles of economics and business intelligence	Data Visualisation	Data Visualization
			Business Analytics (Descriptive, Predictive, Prescriptive)	
			Dashboards & Visual Analytics	
			Data Mining	
			Machine Learning	
			Artificial Intelligence	

Most of the programmes include an introduction to Python, followed by modules on how to apply it, in the context of data analysis and management. Machine learning is also a

common field introduced by some programmes, while others focus on visualisation of data results.

It should be highlighted that almost none of the providers (with the exception of the National and Kapodistrian University of Athens) offer information in terms of the number of ECVET credits acquired by the successful completion of each module, and therefore, their comparison in terms of transparency and skills recognition cannot be established. Depending on the scope of each aforementioned programme, the structure of the course is somewhat different, however, the main elements remain similar when dealing with a VET programme related to Data Science.

Another important aspect of the comparison is that the target group (i.e., eligible candidates to attend the programmes) is of similar nature and applies to the same type of graduates and/or professional groups. The only exception is the programme offered by the ReGeneration Academy, which only targets young graduates with no experience at all, or up to three years, which on one hand reveals the need on behalf of the labour market for specialisation in the field, but it also indicates an effort to facilitate the specialisation of people with no experience at all, as a means to enhance their employability potential.

A similar comparison of SEnDIng IoT VET program with the identified IoT programmes was also carried out.

Table 9: Comparison of already existing IoT VET programmes with the one developed under the SEnDIng Project

EKPA	HOU	University of Aegean	SEnDIng
Internet of Things architecture	Integrated System Design/ System on Chip Design Methodologies Using FPGAs	Introduction to IoT	Introduction to IoT
Introduction to the 4th Industrial Revolution	Modern microcontroller architectures and programming	Architecture and Communication in the context of an IoT system;	IoT Devices
IoT Applications	Wireless Sensor Networks (WSN) and Internet of Things	Cloud IT and data processing	IoT Communication Technologies
Python & Machine learning		Security and data integrity	Architectural Design and Applications in IoT
			IoT Security and Privacy
			IoT Business Value

From the review carried out, it has been concluded that the offer of VET courses on IoT systems is much more limited than the Data of Science field. In particular, the programmes are of a much shorter duration and they cover the basic aspects. Security issues are only presented in the course offered by the University of Aegean, while machine learning is covered by the course of the National and Kapodistrian University of Athens. The SEnDIng programme developed is considered to be a much more comprehensive one, comprised of topics that may take the learner much further than the current ones. Under this prism, the SEnDIng partnership has developed a course which is not only innovative, but also much more elaborated and it is expected to achieve the learning objectives set successfully.

The comparison of the courses has been carried out only against the offer in Greece, being that in the other two countries no relevant courses have been identified.

4 Accreditation methodology of VET programmes in the participating countries

4.1 Accreditation process in Greece

Based on the Law 4547/2018 (A' 102), it is defined that as of the 1st September 2020, all lifelong learning training centres are obliged to provide accredited training programmes. The accreditation process will be undertaken by EOPPEP (the National Organisation for the Certification of Qualifications and Vocational Guidance). The Common Ministerial Decision which will define the process, requirements and cost of training programmes certification has not yet been published.

4.2 Accreditation process in Bulgaria

The State Educational Standards (SES) for acquiring professional qualifications from the List of Professions for Vocational Education and Training (LPVET) under Art. 6 of the Vocational Education and Training Act (VETA) are documents that pursuant to Art. 42, paragraph 3 (b) of VETA. They are developed and updated by the National Agency for Vocational Education and Training (NAVET) and are approved by regulations of the Minister of Education and Science in coordination with the respective ministries and administrative units. The state educational standards for acquiring professional qualifications define the obligatory professional competences required for practicing the profession and they are mandatory for all training institutions entitled to organize training courses and to issue the corresponding certificates of vocational qualification or training upon their completion.

The state educational standards by professions include:

- Minimum entry level qualification and education requirements for pupils and adults;
- Opportunity for validation of professional knowledge, skills and competences;
- Description of the profession work activities, responsibilities, personal qualities characteristics of working conditions, equipment and tools;
- Opportunities for continuing vocational training;
- Opportunities for professional development according to the National Classification of Professions and Occupations;
- Units of Learning Outcomes: knowledge, skills, competences;
- Requirements for theoretical and practical training facilities;
- Requirements for trainers.

In 2014, SES are developed in terms of Units of learning outcomes. The model of Units of learning outcomes is:

- Name of the unit;

- NQF level;

- EQF level;

- Learning outcomes (Knowledge, Skills, Competences);

- Assessment tools;

- Conditions during the assessment;

- Assessment criteria.

The state educational standards for acquiring professional qualifications provide the necessary information regarding:

- Individual career planning;

- Developing curricula and syllabi;

- Planning human resources development in enterprises;

- Personnel selection and employment;

- Personnel training and competences assessment;

- Developing proposals for changes in the content of vocational training.

The List of Professions for Vocational Education and Training is an open system and updates are done in the same manner as when it was initially compiled. According to Art. 54, point 2 of the Vocational Education and Training Act, proposals for changes in the List of Professions for Vocational Education and Training can be made by the national represented organisations of employers, professionals as well as by the structures of the state authorities, including NAVET or the relevant domain ministries. The proposals are considered by the corresponding Expert Committees with the Agency and then are approved by the Managing Board of NAVET. NAVET processes the proposals but does not explicitly request them to make such. The LPVET is published in the specialised editions of Ministry of Education and Science and other specialised publications for the purpose. The sector ministries and the formally recognised employers' organisations could make proposals for changes in the List for VET which should be approved by the Expert Committees and the Managing board of NAVET. NAVET forms the Expert committees among all stakeholders who declare will and motivation to participate in the related Expert Committee. The procedures and guidelines for work of Expert committees are regulated by *Internal rules for terms and conditions for development of State Educational Standards* and *Framework requirements for development of the state educational standards for acquiring professional qualifications* developed by NAVET.[6]

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[6] https://www.navet.government.bg/en/explanatory-notes-to-the-list-of-professions-for-vocational-education-and-training/

4.3 Accreditation process in Cyprus

The Vocational Training Centres (VTCs) submit to the Human Resource Development Authority (HRDA) applications for approval for programmes to be implemented within each semester.

Each application shall be examined whether it satisfies the conditions laid down in the plan and, provided that these are met, is then evaluated on the basis of predefined criteria and graded for approval purposes. The basic conditions are:

(a) Conditions relating to the programme:

    i. The subject of the programme to fall within the agenda set by the HRDA;

    ii. The programme to include the elements required for consideration, such as programme title, start and end date, duration of training, place of application, days and hours of application, right of participation, need for training, training objectives, description of candidates for participation, training methods and techniques, means and training materials, data retention system, evaluation system, proposed instructor data, analytical timetable and training certification;

    iii. The existence of a work-based learning part with practical applications within the company/organisation;

    iv. The duration of the training of the programme falls within the predetermined timeframe;

    v. Number of participants should be within the minimum and maximum limits provided;

    vi. The maximum number of participants in relation to the capacity of the Vocational Training Structure (VTS), but in relation to the subject of the programme, to ensure its effective and qualitative implementation.

(b) Conditions relating to VTC:

    i. The VTC has been certified through the system of evaluation and certification of the Training Providers of the HRDA;

    ii. The VTC is already active in the field of the organisation of training activities;

    iii. The VTC is not under administrative sanctions for the exclusion of cooperation with the HRDA.

(c) Conditions relating to the Vocational Training Structure (VTS):

    i. The VTS proposed for the purposes of implementing the programme have been certified through the system of evaluation and certification of training providers of HRDA;

ii. The VTS proposed, including their premises, equipment and capacity should ensure the effective and qualitative implementation of the programme;

iii. The VTS is not under administrative sanctions for the exclusion of cooperation with the HRDA.

(d) Conditions relating to trainers:

i. The proposed trainers meet the minimum conditions laid down in the plan regarding their education, professional, educational and advisory experience;

ii. The trainer is not under administrative sanctions for the exclusion of cooperation with the HRDA.

(e) Criteria relating to the programme:

i. The completeness and appropriateness of the programme for the effective satisfaction of the training needs of the group of employees in which they aim;

ii. The completeness and suitability of the operational part for effective satisfaction of the training needs of the employees' group in which they are targeted;

iii. The training and the professional and advisory experience of the trainers proposed in relation to the subject of the programme;

iv. The use of appropriate educational instruments and training methods;

v. According to the data and information contained in the application, the programme should be offered for the effective satisfaction of the training needs of the employees' group to which it aims. In particular, the specification of the programme must satisfy all the points below and there is also consistency between them.

Table 10: Evaluation criteria and scores of VET programmes in Cyprus

#	Criterion	Assessment Data	Scale	Grade	Weight	Score
1	Objectives	• Clear, with a purity in the wording • Linked to the subject of the programme • Focused • Realistic/Achievable	0-4		15	max 60
2	Analytical programme and Structure	• Clear wording of the content • Walkthrough • Relevance to the objectives • Comprehensive coverage of the issue • Integrating effective training methods	0-4		45	max 180

#	Criterion	Assessment Data	Scale	Grade	Weight	Score
		• Satisfactory duration • Effective sequence of training modules				
3	Work-based Learning (intra enterprise)	• Relevance of the intra-business to the institutional part of the programme • Objectives ○ Clear, with a purity in the formulation ○ linked to the subject ○ programme specialised in the company • Clear wording of the content of the visit • Satisfactory duration	0-4		20	max 80
4	Candidates for participation	• Clear definition of professional team • Immediacy of professional relationship with the subject and high degree of responsibility • Homogeneity of the professional team. 8 (maximum 32)	0-4		20	max 80
				Total	100	max 400

5 ECVET Qualifications and ECVET Units of SEnDIng VET programs

We have designed the following two templates in order to define the ECVET Qualifications and ECVET Units of the SEnDIng Data Science and IoT VET programs.

Table 11: Template for ECVET Qualifications

ECVET Qualification	(title)
EQF Level	(the appropriate level)
Modules	(list of the modules)
Training Hours	(total training hours)
ECVET Points	(total ECVET points allocated to the ECVET Qualification)

Table 12: Temple for ECVET units

ECVET Unit	(title [code])	
Reference Qualification(s)	(title of the Qualification(s) that the ECVET Unit is referring to)	
EQF Level	(the appropriate level)	
ECVET Unit Type	(Sector-specific or Common)	
Learning Outcomes	(list of the LOs)	

Knowledge	Skills	Competence		
(theoretical knowledge relevant to every LO the ECVET unit consists of)	(practical aspects which a professional should be able to apply in a work environment)	(abilities to combine several aspects of Knowledge and Skills that the professional will then use in a work environment, but also with special care to social or methodological abilities that may play a significant role)		

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	(ways of accomplishing it, i.e. classes, lectures, workshops, projects during modules etc.)	(duration of face-to-face training)	(weighting grade representing the face-to-face training's contribution to the achievement of the LOs)	(methods for the evaluation of the face-to-face training)

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e-Learning	*(means available to trainees and the programme they will have to follow to complete this)*	*(duration of e-learning)*	*(weighting grade representing the e-learning's contribution to the achievement of the LOs)*	*(methods for the evaluation of the e-learning)*
Work-Based Learning	*(means available to trainees and the programme they will have to follow to complete this)*	*(duration of WBL)*	*(weighting grade representing the WBL's contribution to the achievement of the LOs)*	*(methods for the evaluation of WBL)*
Total Training Hours	*(sum of the duration of all used training methods)*			
Total ECVET Points	*(attribution of ECVET points considering, i.e. 1 point for every 25-30 hours of training)*			

Based on these 2 templates, the ECVET qualifications and ECVET units of the Data Science and IoT VET programs are presented at the following two sections.

5.1 ECVET qualifications and ECVET units for the SEnDIng Data Science program

5.1.1 ECVET Qualification for Data Science

The following table presents the ECVET qualification for the Data Science VET program developed by SEnDIng.

ECVET Qualification	Data Science
EQF Level	5
Modules	1. Introduction to Data Science - Introduction [DS-EM1] 2. Applied machine learning - Introduction [DS-EM2-I] 3. Applied machine learning - Core [DS-EM2-C] 4. Applied machine learning - Advanced [DS-EM2-A] 5. Python for Data Science - Introduction [DS-EM3-I] 6. Python for Data Science - Core [DS-EM3-C] 7. Python for Data Science - Advanced [DS-EM3-A] 8. Storing and retrieving data - Introduction [DS-EM4-I] 9. Storing and retrieving data - Core [DS-EM4-C] 10. Storing and retrieving data - Advanced [DS-EM4-A] 11. Statistics for Data Science - Introduction [DS-EM5-I] 12. Statistics for Data Science - Core [DS-EM5-C] 13. Statistics for Data Science - Advanced [DS-EM5-A] 14. Data Visualization - Introduction [DS-EM6-I] 15. Data Visualization - Core [DS-EM6-C] 16. Data Visualization - Advanced [DS-EM6-A] 17. Effective communication and presentation [TS-EM1] 18. Change management [TS-EM2] 19. Team working [TS-EM3] 20. Goal setting [TS-EM4] 21. Creative thinking [TS-EM5]
Training Hours	443
ECVET Points	17,7

5.1.2 ECVET Units for the Data Science Modules

5.1.2.1 DS-EM1: Introduction to Data

ECVET Unit	*Introduction to Data Science - Introduction [DS-EM1]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Introduction to Data Science - Introduction [DS-EM1]*

Knowledge	Skills	Competence
• *Knowing the key concepts of Data Science* • *Having an overall knowledge of the major steps involved in tackling a Data Science problem* • *Knowing the different roles involved in Data Science project* • *Being familiar with the main duties of different Data Science roles* • *Being aware of the main tools used by Data Scientists* • *Having a general knowledge of Data Science applications to solve business problems* • *Having an overall knowledge of the main security issues dealing with Data Science*	• *Explaining the key concepts of Data Science* • *Analysing a Data Science problem* • *Identifying the steps of solving a Data Science problem* • *Identifying the different Data Science roles* • *Identifying the main duties of different Data Science roles* • *Communicating the different tools used by Data Scientists* • *Communicating Data Science use cases* • *Identifying the main security issues raised in Data Science projects*	• *Recognising Data Science problems* • *Recognising the limits between different Data Scientist roles* • *Recognising Data Science applications*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*N/A*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*3*	*100.0%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	*NA*	*0*	*0%*	*NA*

Total Training Hours	*3*
Total ECVET Points	*0.1*

5.1.2.2 DS-EM2: Applied machine learning

ECVET Unit	Applied machine learning – Introduction [DS-EM2-I]
Reference Qualification(s)	Data Science
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Applied machine learning – Introduction [DS-EM2-I]

Knowledge	Skills	Competence
• Knowing the main concepts of Machine Learning • Knowing the main aims of Machine Learning systems	• Explaining the key concepts of Machine Learning • Understanding the aim of Machine Learning methods • Understanding what machine learning can do	• Being able to recognize problems that Machine Learning methods can be applied • Being able to understand what

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• Self-paced online training • Asynchronous online training • Learner-centred content • Personalization (Self-study courses)	2	20%	Learners will complete quizzes to apply their newly acquired skills and knowledge
Work-Based Learning	• On-the-job training (OJT) with special assignments and/or job rotation (case studies) • Carefully structured approaches, such as using specific software	8	80%	Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge

Total Training Hours	10
Total ECVET Points	0.4

ECVET Unit	*Applied machine learning - Core [DS-EM2-C]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Applied machine learning - Core [DS-EM2-C]*

Knowledge	Skills	Competence
• *Understanding the functionality of machine learning methods* • *Knowing the different roles involved in Machine Learning project and the duties of each one* • *Being aware of the main toolkits used by Machine Learning*	• *Understanding how machine learning methods operate* • *Identifying the different Machine Learning roles and their duties* • *Understanding the different toolkits used by Machine Learning*	• *Being able to analyze problems and face them with machine learning methods* • *Being able to specify appropriate Machine Learning methods for given problems* • *Being able to apply machine meaning methods and solve problems*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*10*	*29%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*25*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*35*
Total ECVET Points	*1.4*

ECVET Unit	*Applied machine learning – Advanced [DS-EM2-A]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Applied machine learning – Advanced [DS-EM2-A]*

Knowledge	Skills	Competence
• *Having a general knowledge of Machine Learning applications to solve business problems* • *Having an overall knowledge of the main security issues dealing with Machine Learning*	• *Developing practical skills on the application of machine learning methods in various domains* • *Designing & developing machine learning systems to solve real world problem*	• *Being able to design & develop machine learning systems to solve real world problem*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*8*	*29%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*20*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*28*
Total ECVET Points	*1.1*

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5.1.2.3   DS-EM3: Python for Data Science

ECVET Unit	*Python for Data Science – Introduction [DS-EM3-I]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Python for Data Science – Introduction [DS-EM3-I]*

Knowledge	Skills	Competence
• *Having an overall knowledge of the main features of Python programming language* • *Having a general knowledge of the main Python libraries for Data Scientists*	• *Explaining the main characteristics of Python* • *Identifying common applications of Python for data analysis and data visualization*	• *Being competent to promote Python as an effective programming language for solving Data Science problems*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*2*	*20%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*8*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*10*
Total ECVET Points	*0.4*

ECVET Unit	*Python for Data Science – Core [DS-EM3-C]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Python for Data Science – Core [DS-EM3-C]*

Knowledge	Skills	Competence
• *Having a detailed knowledge of the different types of Python variables* • *Having a detailed knowledge of the different types of Python built-in datatypes* • *Having a detailed knowledge of the different types of Python statements* • *Learning how to use functions in Python* • *Learning how to use classes in Python* • *Learning how to use modules in Python* • *Learning how to handle data files with python*	• *Creating simple python programs* • *Troubleshooting simple python programs*	• *Being competent to taking some responsibility in Data Science projects*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*12*	*29%*	*Learners will be assessed through Questionnaires and solve use cases to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*30*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*42*
Total ECVET Points	*1.7*

ECVET Unit	Python for Data Science - Advanced [DS-EM3-A]
Reference Qualification(s)	Data Science
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Python for Data Science - Advanced [DS-EM3-A]

Knowledge	Skills	Competence
• Having detailed knowledge of NumPy package to effectively create big arrays and matrixes with Python • Having detailed knowledge of Pandas library to analyse data with Python • Having detailed knowledge of Matplotlib library to visualize data with Python • Having detailed knowledge of Scikit-Learn to implement machine learning algorithms with Python	• Using NumPy Python library for big data manipulation • Making big data analysis with Pandas Python library • Making data visualization using the Matplotlib Python library • Using the Scikit-Learn Python for running machine learning algorithms • Using Python for data analysis, data visualization and machine learning	• Being capable of taking some responsibility in Data Science projects • Becoming more effective in solving Data Science problems

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• Self-paced online training • Asynchronous online training • Learner-centred content • Personalization (Self-study courses)	6	20%	Learners will be assessed through questionnaires and carry out hands-on activities to apply their newly acquired skills and knowledge
Work-Based Learning	• On-the-job training (OJT) with special assignments and/or job rotation (case studies) • Carefully structured approaches, such as using specific software	24	80%	Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge

Total Training Hours	30
Total ECVET Points	1.2

5.1.2.4   DS-EM4: Storing and retrieving data

ECVET Unit	*Storing and retrieving data – Introduction [DS-EM4-I]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Storing and retrieving data – Introduction [DS-EM4-I]*

Knowledge	Skills	Competence
• *Being introduced to the Hadoop components and the Hadoop ecosystem* • *Knowing the unique features of Hadoop* • *Being familiar with the basic architecture of a Hadoop cluster*	• *Classifying the Hadoop framework* • *Explaining the unique features of Hadoop* • *Describing the basic architecture of a Hadoop cluster*	• *Being competent to promote Hadoop in storing and managing vast amounts of data efficiently*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*4*	*20%*	*Learners will complete self- assessment quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*16*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*
Total Training Hours	*20*			
Total ECVET Points	*0.8*			

ECVET Unit	*Storing and retrieving data - Core [DS-EM4-C]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Storing and retrieving data - Core [DS-EM4-C]*

Knowledge	Skills	Competence
• *Knowing the architectural differences between Hadoop 1 and Hadoop 2* • *Having a general knowledge of the data types that can be handled with Hadoop* • *Having a good understanding of the Hadoop Distributed File System (HDFS)* • *Having a good understanding of the Hadoop Operating System (YARN – Yet Another Resource Negotiator)* • *Knowing how to perform basic administration tasks for key Hadoop components from command line*	• *Explaining the architectural differences between Hadoop 1 and Hadoop 2* • *Supporting the main data types that can be handled with Hadoop framework* • *Using the storage (HDFS) and processing (YARN) layer of Hadoop* • *Managing key Hadoop components and modules from UNIX/Linux command line*	• *Demonstrating Hadoop as an effective programming framework to manage (store) and analyse (retrieve) big data* • *Becoming more flexible in Hadoop administration*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*10*	*29%*	*Learners will complete self- assessment quizzes and carry out hands-on activities to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*25*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*35*
Total ECVET Points	*1.4*

ECVET Unit	*Storing and retrieving data – Advanced [DS-EM4-A]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Storing and retrieving data – Advanced [DS-EM4-A]*

Knowledge	Skills	Competence
• *Having a good understanding of the MapReduce Framework* • *Having a general knowledge of the Hive interface and the Pig high-level framework* • *Having a good understanding of the Spark Framework* • *Knowing the key concepts of Hadoop security*	• *Using the MapReduce Framework and the Spark Framework* • *Explaining the key concepts of both the Hive interface and the Pig high-level framework* • *Assisting in securing a Hadoop environment*	• *Being able to recognize the limits of the MapReduce Framework and migrate to the Spark Framework* • *Being aware and sensitive with Hadoop security concepts*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*6*	*20%*	*Learners will complete self-assessment quizzes, participate in use cases and carry out hands-on activities to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*24*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*30*
Total ECVET Points	*1.2*

5.1.2.5 DS-EM5: Statistics for Data Science

ECVET Unit	Statistics for Data Science – Introduction [DS-EM5-I]
Reference Qualification(s)	Data Science
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Statistics for Data Science – Introduction [DS-EM5-I]

Knowledge	Skills	Competence
• Having an overall knowledge of the main features of R programming language • Having a general knowledge of the main R packages for Data Science statistical tasks	• Explaining the main characteristics of R • Identifying common applications of R for the statistical analysis of data	• Being competent to promote R as an effective programming language for solving Data Science problems that regard statistical analysis

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• Self-paced online training • Asynchronous online training • Learner-centred content • Personalization (Self-study courses)	2	20%	Learners will complete quizzes to apply their newly acquired skills and knowledge
Work-Based Learning	• On-the-job training (OJT) with special assignments and/or job rotation (case studies) • Carefully structured approaches, such as using specific software	8	80%	Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge
Total Training Hours	10			
Total ECVET Points	0.4			

ECVET Unit	Statistics for Data Science - Core [DS-EM5-C]
Reference Qualification(s)	Data Science
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Statistics for Data Science - Core [DS-EM5-C]

Knowledge	Skills	Competence
• *Having detailed knowledge of the different types of R variables* • *Having detailed knowledge of the different types of R built-in data types* • *Having detailed knowledge of the different types of R statements* • *Learning how to use functions in R* • *Learning how to use R packages and libraries* • *Learning how to handle data files with R*	• *Creating simple R programs for statistical analysis (descriptive statistics for data science).* • *Troubleshooting simple R programs*	• *Being competent to taking some responsibility in Data Science projects that regard statistical analysis*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	10	29%	*Learners will be assessed through Questionnaires and solve use cases to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	25	71%	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	35
Total ECVET Points	1.4

ECVET Unit	*Statistics for Data Science – Advanced [DS-EM5-A]*
Reference Qualification(s)	*Data Science*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Statistics for Data Science – Advanced [DS-EM5-A]*

Knowledge	Skills	Competence
• *Having detailed knowledge of R built-in functions and libraries to effectively calculate and visualize sampling distributions and estimations, apply hypothesis testing, correlation and regression models* • *Having detailed knowledge ggplot2 and plotly libraries to generate data visualizations with R* • *Having detailed knowledge mlr, dmlc XGBoost and caret libraries to implement machine learning algorithms with R*	• *Using R to calculate and visualize sampling distributions and estimations, apply hypothesis testing, correlation and regression models* • *Producing data visualizations with the ggplot2 and plotly libraries* • *Applying machine learning algorithms with the mlr, dmlc XGBoost and caret libraries*	• *Being capable of taking some responsibility in Data Science projects involving statistical analysis* • *Becoming more effective in solving Data Science statistical problems using R*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*8*	*29%*	*Learners will be assessed through questionnaires and carry out hands-on activities to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*20*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*28*
Total ECVET Points	*1.1*

5.1.2.6 DS-EM6: Data Visualization

ECVET Unit	Data Visualization – Introduction [DS-EM6-I]
Reference Qualification(s)	Data Science
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Data Visualization – Introduction [DS-EM6-I]

Knowledge	Skills	Competence
• Knowing the key concepts of Data Visualization and Data Presentation Architecture • Having an overall knowledge of the fundamental principles of visual information / information graphics / statistical graphics	• Explaining the key concepts of Data Visualization and Data Presentation Architecture • Communicating the fundamental principles of visual information / information graphics / statistical graphics • Assisting in visual information problems	• Being able to deal with information and statistical graphics

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• Self-paced online training • Asynchronous online training • Learner-centred content • Personalization (Self-study courses)	2	20%	Learners will complete self-assessment quizzes to apply their newly acquired skills and knowledge
Work-Based Learning	• On-the-job training (OJT) with special assignments and/or job rotation (case studies) • Carefully structured approaches, such as using specific software	8	80%	Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge
Total Training Hours	10			
Total ECVET Points	0.4			

ECVET Unit	Data Visualization - Core [DS-EM6-C]
Reference Qualification(s)	Data Science
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Data Visualization - Core [DS-EM6-C]

Knowledge	Skills	Competence
• Being familiar with well-established Communication / Presentation methodologies • Being aware of various innovative software tools and programs used to efficiently visualize business datasets • Knowing specifically to design effective Visualizations / Presentations	• Applying common Data Visualization techniques and methods to real business and/or big datasets • Communicating the different software tools and programs used for Data Visualization • Delivering effective and targeted visual stories and presentations	• Being able to recognize trends and patterns • Demonstrating visual stories

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• Self-paced online training • Asynchronous online training • Learner-centred content • Personalization (Self-study courses)	10	29%	Learners will complete self- assessment quizzes and carry out hands-on activities to apply their newly acquired skills and knowledge
Work-Based Learning	• On-the-job training (OJT) with special assignments and/or job rotation (case studies) • Carefully structured approaches, such as using specific software	25	71%	Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge

Total Training Hours	35
Total ECVET Points	1.4

ECVET Unit	Data Visualization – Advanced [DS-EM6-A]
Reference Qualification(s)	Data Science
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Data Visualization – Advanced [DS-EM6-A]

Knowledge	Skills	Competence
• Having a detailed knowledge of advanced Data Visualization techniques and methods • Being familiar with visual data mining in complex datasets	• Applying advanced Data Visualization techniques and methods to real business and/or big datasets • Effectively communicating data • Promoting visual communication • Performing visual data mining in massive representations of data	• Becoming more effective in Data Visualization problems / issues • Demonstrating engaging data visualizations • Being competent in visually representing massive amounts of information and making data-driven decisions

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• Self-paced online training • Asynchronous online training • Learner-centred content • Personalization (Self-study courses)	8	29%	Learners will complete self- assessment quizzes, participate in use cases and carry out hands-on activities to apply their newly acquired skills and knowledge
Work-Based Learning	• On-the-job training (OJT) with special assignments and/or job rotation (case studies) • Carefully structured approaches, such as using specific software	20	71%	Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge
Total Training Hours	28			
Total ECVET Points	1.1			

5.1.2.7 TS: Transversal Skills Modules

ECVET Unit	Transversal Skills [TS]
Reference Qualification(s)	Data Science, Internet of Things (and many more professional qualifications)
EQF Level	5
ECVET Unit Type	Common
Learning Outcomes	1. Effective communication and presentation [TS-EM1] 2. Change management [TS-EM2] 3. Team working [TS-EM3] 4. Goal setting [TS-EM4] 5. Creative thinking [TS-EM5]

Knowledge	Skills	Competence
[TS-EM1] • Knowing the principles of effective verbal and non-verbal communication • Having a comprehensive understanding of the principles of active listening • Being acquainted with the possible barriers to communication • Having a thorough knowledge about the principles of effective communication with clients and colleagues • Knowing possible techniques to adapt communication style depending on the scope of the message and feedback received • Havinge an overall knowledge about the principles of effective presentations	[TS-EM1] • Analysing the factors related to communication with colleagues and clients • Tailoring their communication strategy according to the specificities of each encounter • Communicating with clarity and conviction • Encouraging participation and interaction when presenting to colleagues or clients	[TS-EM1] • Adapting effectively to challenging situations in communication • Listening actively • Developing self-awareness in communication • Presenting technical information clearly, concisely and persuasively
[TS-EM2] • Knowing what change is about and why it is inevitable in the business environment • Having a good understanding about the importance of developing resilience to change • Being acquainted with the process of transition through change • Having a general knowledge about change management processes	[TS-EM2] • Overcoming resistance to change • Supporting their organization in implementing changes	[TS-EM2] • Developing a willingness to move from their comfort zone and accept changes in their working environment

[TS-EM3] • *Having a comprehensive understanding about the characteristics, principles and advantages of teamwork* • *Being familiar with the characteristics of a balanced team* • *Being aware of the roles and responsibilities of the members and leader of a team* • *Having a good understanding about techniques of setting team objectives* • *Having an overall knowledge about principles of developing an effective team* • *Having e a basic understanding of team leadership* • *Knowing the principles of effective communication within teams*	**[TS-EM3]** • *Setting a common vision and objectives within a team* • *Being active within a team and improving their teamwork* • *Motivating the other members of a team* • *Handling conflicts within a team*	**[TS-EM3]** • *Recognizing different personality types within a team* • *Defining individual and team expectations* • *Understanding team dynamics* • *Improving team motivation* • *Promoting the formation and development of teams in ICT environment*
[TS-EM4] • *Having a good understanding of the meaning and importance of goal setting* • *Knowing the goal setting process* • *Knowing goal setting techniques and tools*	**[TS-EM4]** • *Identifying what they want to achieve in their professional life* • *Initiating and running a goal-setting process* • *Using goal-setting tools and techniques*	**[TS-EM4]** • *Being competent in planning professional goals* • *Being able to look at their professional role and what services can provide to other people* • *Including other people from their work environment into their goal setting process*
[TS-EM5] • *Understanding different forms and definitions of creativity* • *Being acquainted with the phases of creative problem-solving procedures* • *Being familiar with tools of creative thinking* • *Having a general understanding about the characteristics of a creative environment* • *Understanding the concept of agile thinking*	**[TS-EM5]** • *Gathering information about a problem* • *Identifying and analysing problems* • *Using techniques in order to generate ideas* • *Managing a creative thinking process* • *Organizing ideas and select the best solutions* • *Using agile thinking in order to provide valuable solutions*	**[TS-EM5]** • *Being curious about why things are and trying to understand the dynamics of a situation* • *Seeing problems in a more positive way* • *Developing ideas into valuable solutions to the problems* • *Using creative thinking methodologies in order to support their clients* • *Thinking out of the box when they are trying to provide a solution*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	• *Promote self-directed learning* • *Address all perception channels (visual, auditory and kinesthetic) and cater for different learning styles, when used in combination* • *Presentation of information* • *Promote experiential, transformational, collaborative and active learning* • *Exploitation activities* • *Application in practice*	*20*	*37%*	*Learner's evaluation is carried out through observation checklists, questionnaires and self-assessment*
e-Learning	*NA*	*0*	*0%*	*NA*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*34*	*63%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*
Total Training Hours	*54*			
Total ECVET Points	*2.2*			

5.2 ECVET qualifications and ECVET units for the SEnDIng Internet of Things program

5.2.1 ECVET Qualification for Internet of Things

The following table presents the ECVET qualification for the Internet of Things VET program developed by SEnDIng.

ECVET Qualification	Internet of Things
EQF Level	5
Learning Outcomes	1. Introduction to IoT [IoT-EM1] 2. Architectural Design and Applications in IoT - Introduction [IoT-EM2-I] 3. Architectural Design and Applications in IoT – Core [IoT-EM2-C] 4. Architectural Design and Applications in IoT - Advanced [IoT-EM2-A] 5. IoT Communication technologies - Introduction [IoT -EM3-I] 6. IoT Communication technologies - Core [IoT -EM3-C] 7. IoT Communication technologies - Advanced [IoT-EM3-A] 8. IoT Security and Privacy - Introduction [IoT-EM4-I] 9. IoT Security and Privacy - Core [IoT-EM4-C] 10. IoT Security and Privacy - Advanced [IoT-EM4-A] 11. IoT Devices - Introduction [IoT -EM5-I] 12. IoT Devices - Core [IoT -EM5-C] 13. IoT Devices - Advanced [IoT-EM5-A] 14. IoT Business Value - Introduction [IoT-EM6-I] 15. IoT Business Value - Core [IoT-EM6-C] 16. IoT Business Value - Advanced [IoT-EM6-A] 17. Effective communication and presentation [TS-EM1] 18. Change management [TS-EM2] 19. Team working [TS-EM3] 20. Goal setting [TS-EM4] 21. Creative thinking [TS-EM5]
Training Hours	*443*
ECVET Points	*17.7*

5.2.2 ECVET Units for the Internet of Things Modules

5.2.2.1 IoT-EM1: Introduction to IoT

ECVET Unit	*Introduction to IoT [IoT-EM1]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Introduction to IoT [IoT-EM1]*

Knowledge	Skills	Competence
• *Knowing the key concepts of IoT* • *Knowing the synergies between adjacent links in the IoT value chain* • *Knowing the different roles involved in an IoT project,* • *Being aware of the technology components of the IoT puzzle that have matured over time* • *Being familiar with the main duties of different engineering and business analyst roles in an IoT project* • *Having detailed knowledge of the expertise of the groups that compose an IoT application development team* • *Having detailed knowledge of the methodologies to create workflows* • *Having detailed knowledge of the Device Management functions* • *Being able to select the appropriate development platform for their application*	• *Being able to identify an opportunity for applying a solution by adopting the IoT paradigm* • *Being able to select and evaluate the effectiveness of the appropriate business model of a product offering in any of the links of IoT value chain* • *Being able to identify an opportunity for applying a solution by adopting the IoT paradigm* • *Identifying the different IoT roles* • *Identifying the main technologies and their contribution to various IoT Projects* • *Specifying the responsibilities of the IoT specialists and the synergies among them* • *Selecting and configure the edge computing platform which is appropriate for their application* • *Designing SQL database schemas in their workflows and work with NoSQL databases* • *Selecting and using the dataflow design platform according to their programming skills and expertise* • *Selecting the method and tools for data visualization*	• *Being competent to create a business model for a certain IoT product or service* • *Being able to recognize the limits between different IoT roles* • *Being capable of taking some responsibility in the IoT Application Development process* • *Participating to system level architecture and design of IoT solutions*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*3*	*100%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	*NA*	*0*	*0%*	*NA*

Total Training Hours	*3*
Total ECVET Points	*0.1*

5.2.2.2 IoT-EM2: Architectural Design and Applications in IoT

ECVET Unit	Architectural Design and Applications in IoT - Introduction [IoT-EM2-I]
Reference Qualification(s)	Internet of Things
EQF Level	5
ECVET Unit Type	Sector-specific (ICT)
Learning Outcomes	Architectural Design and Applications in IoT - Introduction [IoT-EM2-I]

Knowledge	Skills	Competence
• Being familiar with the roles of sensors, actuators, gateways and server-side infrastructure in an IoT architecture • Being familiar with the interaction patterns between edge devices and server-side architecture • Having detailed knowledge of the different server-side infrastructure solutions with emphasis on physical servers, virtual servers, virtual private servers and cloud computing • Being aware of the cloud computing service models: Infrastructure as a Service, Platform as a Service, Software as a Service • Being aware of public/private/hybrid/community cloud deployment models • Being familiar with fog and edge computing concepts • Being aware of basic features available in public cloud providers related to computation, big-data, analytics, intelligence, IoT, security, identification, access and developer operations • Being familiar with Microsoft Azure cloud and IoT related services	• Identifying the available server-side infrastructure solutions • Explaining the the cloud computing service and deployment models • Creating account on public cloud provider • Using IoT services within a public cloud account • Simulating an IoT device sending data on the cloud on Python programming language	• Being competent to create public cloud accounts and use IoT related services

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	NA	0	0%	NA
e-Learning	• Self-paced online training • Asynchronous online training • Learner-centred content • Personalization (Self-study courses)	4	20%	Learners will complete quizzes to apply their newly acquired skills and knowledge

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Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*16*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*
Total Training Hours	*20*			
Total ECVET Points	*0.8*			

ECVET Unit	*Architectural Design and Applications in IoT - Core [IoT-EM2-C]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Architectural Design and Applications in IoT - Core [IoT-EM2-C]*

Knowledge	Skills	Competence
• *Being familiar with the non-functional requirements (quality attributes) that should be taken into account when designing an IoT Application* • *Being aware of the major areas of activity (applications) in IoT* • *Having knowledge of the widely known IoT applications along with their characteristics* • *Getting involved in classifying the presented IoT applications based on their purpose* • *Having a detailed knowledge of software architectural styles available in IoT which determine the organization of IoT architecture constituent components and describe the relationships among them*	• *Explaining the non-functional requirements which are important in IoT* • *Explaining the main characteristics of a given IoT Application* • *Identifying software architectural styles available in IoT*	• *Being able to recognize the characteristics of any IoT Application* • *Being competent to promote software architectural styles for an IoT Application based on the required quality attributes*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*8*	*29%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*20*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*28*
Total ECVET Points	*1.1*

ECVET Unit	*Architectural Design and Applications in IoT - Advanced [IoT-EM2-A]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*Architectural Design and Applications in IoT - Advanced [IoT-EM2-A]*

Knowledge	Skills	Competence
• *Having detailed knowledge of important considerations which should be taken into account when designing an IoT Application* • *Learning how to build an abstract realization of an architectural model (reference architecture) showing how an IoT application can be built while omitting any reference to specific technologies* • *Learning how to use a public cloud provider (Microsoft Azure) and its related IoT and data analysis (machine learning) services to create real-world IoT Applications (a simulated Raspberry Pi will be used)*	• *Making decisions on hardware and software components when designing an IoT Application* • *Designing a reference architecture for a specific IoT Application when being aware of the functional and non-functional requirements* • *Using a world class public cloud provider to build real-world IoT applications*	• *Being capable of taking some responsibility in designing and implementing IoT Applications*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*8*	*29%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*20*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*28*
Total ECVET Points	*1.1*

5.2.2.3 IoT-EM3: IoT Communication Technologies

ECVET Unit	IoT Communication technologies - Introduction [IoT -EM3-I]
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Communication technologies - Introduction [IoT -EM3-I]*

Knowledge	Skills	Competence
• *Having an overall knowledge of the network technologies commonly used in IoT* • *Understanding the pros and cons of each technology for an IoT application*	• *Selecting the right network type as well as the appropriate equipment (e.g. gateways) and device's technology*	• *Creating a proposal for equipment an IoT application requires, based on the appropriate selection of the network type*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*2*	*20%*	*Learners will be assessed via Questionnaires*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*8*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*
Total Training Hours	*10*			
Total ECVET Points	*0.4*			

ECVET Unit	IoT Communication technologies - Core [IoT -EM3-C]
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Communication technologies - Core [IoT -EM3-C]*

Knowledge	Skills	Competence
• *Having good knowledge of LPWAN technologies* • *Having a good knowledge of the types of platforms required for end-to-end application development over various LPWAN technologies* • *Having a good understanding of the design principles of edge systems vs the network access method*	• *Architecting a system over a certain type of LPWAN* • *Making cost assessment related to the selection of equipment for the use of a specific LPWAN*	• *Being capable of taking some responsibility in system architecture and business analysis of IoT solutions over LPWAN IoT networks*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*8*	*29%*	*Learners will be assessed via Questionnaires*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*20*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*28*
Total ECVET Points	*1.1*

ECVET Unit	*IoT Communication technologies - Advanced [IoT-EM3-A]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Communication technologies - Advanced [IoT-EM3-A]*

Knowledge	Skills	Competence
• *Having detailed knowledge of the network access protocols* • *Having detailed knowledge of how to interface with the platform of the IoT Network provider* • *Having detailed knowledge of how to setup a private IoT network*	• *Exchanging data with the core IoT network* • *Programming or use an edge computing system to send data to a carrier* • *Applying design rules for low power bi-direction edge network devices*	• *Being able to setup the infrastructure required for the data flow between edge devices and an IoT application development platform*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*10*	*29%*	*Learners will be assessed through Questionnaires and solve use cases to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*25*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*35*
Total ECVET Points	*1.4*

5.2.2.4 IoT-EM4: IoT Security and Privacy

ECVET Unit	*IoT Security and Privacy - Introduction [IoT-EM4-I]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Security and Privacy - Introduction [IoT-EM4-I]*

Knowledge	Skills	Competence
• *Gaining the basic knowledge on security in the IoT*	• *Understanding the importance of incorporating security measures within the IoT* • *Understanding all terms defined* • *Being aware of the consequences of the IoT being under attack* • *Being aware basic attacks* • *Being aware common countermeasure techniques*	*NA*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*2*	*20%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge that include Multiple choice questions, and True/False questions*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*8*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*10*
Total ECVET Points	*0.4*

ECVET Unit	IoT Security and Privacy - Core [IoT-EM4-C]
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Security and Privacy - Core [IoT-EM4-C]*

Knowledge	Skills	Competence
• *Gaining the basic knowledge on security in the IoT*	• *Identifying vulnerabilities in IoT applications* • *Understanding the importance of preventing and detecting an attack with real life examples* • *Knowing common countermeasures and adapt these measures to their personal and work IoT nodes and/or networks* • *Critically evaluating the potential countermeasures to attack techniques in order to evade attacks*	*NA*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*8*	*29%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge that include Multiple choice questions, and True/False questions*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*20*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*28*
Total ECVET Points	*1.1*

ECVET Unit	*IoT Security and Privacy - Advanced [IoT-EM4-A]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Security and Privacy - Advanced [IoT-EM4-A]*

Knowledge	Skills	Competence
• *Simulating an IoT environment* • *Network monitoring and recognizing possible malicious network traffic and simulating an IoT*	• *Reading and understanding network traffic from and to a private IoT network* • *Simulating network traffic* • *Detecting possible malicious network traffic*	*NA*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*10*	*29%*	*Learners will complete quizzes to apply their newly acquired skills and knowledge that include Multiple choice questions, and True/False questions*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*25*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*35*
Total ECVET Points	*1.4*

5.2.2.5   IoT-EM5: IoT devices

ECVET Unit	IoT Devices - Introduction [IoT -EM5-I]
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	IoT Devices - Introduction [IoT -EM5-I]

Knowledge	Skills	Competence
• *Having an overall knowledge of the electronics of the IoT devices* • *Being able to distinguish IoT devices and their role in IoT applications*	• *Writing simple programs to read values from basic IoT sensors* • *Designing and implement simple circuits integrating basic IoT sensors*	• *Being competent to accept responsibilities in projects that require low level integration with IoT devices/sensors*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*2*	*20%*	*Learners will be assessed via quizzes, reports, presentation, demonstration and examination*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*8*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*
Total Training Hours	*10*			
Total ECVET Points	*0.4*			

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ECVET Unit	*IoT Devices - Core [IoT -EM5-C]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Devices - Core [IoT -EM5-C]*

Knowledge	Skills	Competence
• *Having a detailed knowledge of the electronics of the IoT devices* • *Understanding passive and active components* • *Being able to differentiate sensors and actuators and their role in different IoT applications*	• *Troubleshooting and solving IoT devices issues* • *Designing and implementing IoT systems integrating sensors and actuators* • *Writing programs to read sensor data and interface with actuators*	• *Being competent to participate to IoT system design and integration with different sensors and actuators*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*6*	*20%*	*Learners will be assessed via quizzes, reports, presentation, demonstration and examination*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*24*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*30*
Total ECVET Points	*1.2*

ECVET Unit	*IoT Devices - Advanced [IoT-EM5-A]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Devices - Advanced [IoT-EM5-A]*

Knowledge	Skills	Competence
• *Having an advanced knowledge of the electronics of the IoT devices* • *Understanding the concept of open and closed loop systems* • *Being able to select the correct microcontroller for a problem solving*	• *Troubleshooting and solving IoT devices advanced issues* • *Selecting the correct sampling frequency for different sensors* • *Programming GPIOs to support communication with a variety of sensors and actuators* • *Being able to read data from any kind of sensor (IR, cameras, accelerometers, ultrasonic sensors, etc) or actuators like motors*	• *Being competent to take the lead in any kind of IoT project integrating different types of sensors, actuators in either open or closed loop systems*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*12*	*29%*	*Learners will be assessed via quizzes, reports, presentation, demonstration and examination*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*30*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*42*
Total ECVET Points	*1.7*

5.2.2.6　IoT-EM5: IoT Business Value

ECVET Unit	*IoT Business Value - Introduction [IoT-EM6-I]*
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Business Value - Introduction [IoT-EM6-I]*

Knowledge	Skills	Competence
• *Having an overview knowledge of the IoT Business* • *Having a general knowledge of the term business value* • *Having an overview of the IoT technologies in the business world* • *Having a general knowledge of the method used by the devices be connected to each other, as well as their communication method*	• *Explaining how the connection and communication method of the devices work* • *Identifying improvements for future work using IoT business*	• *Being competence to introduce the IoT business in their future works* • *Being capable of tracking some responsibility in IoT projects*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*2*	*20%*	*Learners will be assessed via Questionnaires, quizzes and solve use cases to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*8*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*10*
Total ECVET Points	*0.4*

ECVET Unit	IoT Business Value - Core [IoT-EM6-C]
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Business Value - Core [IoT-EM6-C]*

Knowledge	Skills	Competence
• *Learning the difference in creating a business model for IoT applications and normal products or services* • *Having detailed knowledge of the different business model types in the IoT area* • *Learning how each model type improves the company* • *Learning the three categories of challenges in the IoT* • *Having a general knowledge of the challenges in each category mentioned above* • *Learning how to handle each category*	• *Dealing with each challenge* • *Identifying improvements in the company with model type*	• *Being competent to deal/solve with challenges* • *Being competent to improve the business model type with the IoT business model*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*12*	*29%*	*Learners will be assessed via Questionnaires and solve use cases to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*30*	*71%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	42
Total ECVET Points	1.7

ECVET Unit	IoT Business Value - Advanced [IoT-EM6-A]
Reference Qualification(s)	*Internet of Things*
EQF Level	*5*
ECVET Unit Type	*Sector-specific (ICT)*
Learning Outcomes	*IoT Business Value - Advanced [IoT-EM6-A]*

Knowledge	Skills	Competence
• *Learning different IoT applications/solutions that exist* • *Having general knowledge of the benefits IoT gives based on real life examples of successful companies*	• *Giving an IoT solution to a general problem*	• *Being competent to introduce IoT in the company* • *Being capable of tracking some responsibility in IoT projects*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	*NA*	*0*	*0%*	*NA*
e-Learning	• *Self-paced online training* • *Asynchronous online training* • *Learner-centred content* • *Personalization (Self-study courses)*	*6*	*20%*	*Learners will be assessed via Questionnaires and solve use cases to apply their newly acquired skills and knowledge*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*24*	*80%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*

Total Training Hours	*30*
Total ECVET Points	*1.2*

5.2.2.7   TS: Transversal Skills Modules

ECVET Unit	*Transversal Skills [TS]*
Reference Qualification(s)	*Internet of Things, Data Science (and many more professional qualifications)*
EQF Level	*5*
ECVET Unit Type	*Common*
Learning Outcomes	1. *Effective communication and presentation [TS-EM1]* 2. *Change management [TS-EM2]* 3. *Team working [TS-EM3]* 4. *Goal setting [TS-EM4]* 5. *Creative thinking [TS-EM5]*

Knowledge	Skills	Competence
[TS-EM1] • *Knowing the principles of effective verbal and non-verbal communication* • *Having a comprehensive understanding of the principles of active listening* • *Being acquainted with the possible barriers to communication* • *Having a thorough knowledge about the principles of effective communication with clients and colleagues* • *Knowing possible techniques to adapt communication style depending on the scope of the message and feedback received* • *Havinge an overall knowledge about the principles of effective presentations*	*[TS-EM1]* • *Analysing the factors related to communication with colleagues and clients* • *Tailoring their communication strategy according to the specificities of each encounter* • *Communicating with clarity and conviction* • *Encouraging participation and interaction when presenting to colleagues or clients*	*[TS-EM1]* • *Adapting effectively to challenging situations in communication* • *Listening actively* • *Developing self-awareness in communication* • *Presenting technical information clearly, concisely and persuasively*
[TS-EM2] • *Knowing what change is about and why it is inevitable in the business environment* • *Having a good understanding about the importance of developing resilience to change* • *Being acquainted with the process of transition through change* • *Having a general knowledge about change management processes*	*[TS-EM2]* • *Overcoming resistance to change* • *Supporting their organization in implementing changes*	*[TS-EM2]* • *Developing a willingness to move from their comfort zone and accept changes in their working environment*

[TS-EM3]	[TS-EM3]	[TS-EM3]
• *Having a comprehensive understanding about the characteristics, principles and advantages of teamwork* • *Being familiar with the characteristics of a balanced team* • *Being aware of the roles and responsibilities of the members and leader of a team* • *Having a good understanding about techniques of setting team objectives* • *Having an overall knowledge about principles of developing an effective team* • *Having e a basic understanding of team leadership* • *Knowing the principles of effective communication within teams*	• *Setting a common vision and objectives within a team* • *Being active within a team and improving their teamwork* • *Motivating the other members of a team* • *Handling conflicts within a team*	• *Recognizing different personality types within a team* • *Defining individual and team expectations* • *Understanding team dynamics* • *Improving team motivation* • *Promoting the formation and development of teams in ICT environment*
[TS-EM4]	[TS-EM4]	[TS-EM4]
• *Having a good understanding of the meaning and importance of goal setting* • *Knowing the goal setting process* • *Knowing goal setting techniques and tools*	• *Identifying what they want to achieve in their professional life* • *Initiating and running a goal-setting process* • *Using goal-setting tools and techniques*	• *Being competent in planning professional goals* • *Being able to look at their professional role and what services can provide to other people* • *Including other people from their work environment into their goal setting process*
[TS-EM5]	[TS-EM5]	[TS-EM5]
• *Understanding different forms and definitions of creativity* • *Being acquainted with the phases of creative problem-solving procedures* • *Being familiar with tools of creative thinking* • *Having a general understanding about the characteristics of a creative environment* • *Understanding the concept of agile thinking*	• *Gathering information about a problem* • *Identifying and analysing problems* • *Using techniques in order to generate ideas* • *Managing a creative thinking process* • *Organizing ideas and select the best solutions* • *Using agile thinking in order to provide valuable solutions*	• *Being curious about why things are and trying to understand the dynamics of a situation* • *Seeing problems in a more positive way* • *Developing ideas into valuable solutions to the problems* • *Using creative thinking methodologies in order to support their clients* • *Thinking out of the box when they are trying to provide a solution*

Training Methods		Training Hours	Weight (%)	Assessment Methods
Face-to-Face	• *Promote self-directed learning* • *Address all perception channels (visual, auditory and kinesthetic) and cater for different learning styles, when used in combination* • *Presentation of information* • *Promote experiential, transformational, collaborative and active learning* • *Exploitation activities* • *Application in practice*	*20*	*37%*	*Learner's evaluation is carried out through observation checklists, questionnaires and self-assessment*
e-Learning	*NA*	*0*	*0%*	*NA*
Work-Based Learning	• *On-the-job training (OJT) with special assignments and/or job rotation (case studies)* • *Carefully structured approaches, such as using specific software*	*34*	*63%*	*Learners will be assessed on case studies tailored to the requirements of the workplace, executing work tasks in real time and environment to apply their newly acquired skills and knowledge*
Total Training Hours	*54*			
Total ECVET Points	*2.2*			

6 Conclusions and Recommendations

A desktop research was carried out to identify similar VET programmes which relate to the topics of Data Science and Internet of Things. The research demonstrated that in two of the three participating countries (Bulgaria and Cyprus) no such programmes exist at VET level. In Greece, the partners were able to identify some programmes offered mostly by Universities and one by a business-oriented organisation. The target groups of all identified programmes were similar to the ones of the SEnDing project which demonstrates clearly that there is a pronounced need on behalf of the labour market for the development of qualifications related to these two areas of interest.

The partners were not in the position to collect information on the number of credits acquired through the successful participation in the courses as per the ECVET system, which did not enable the comparison of the programmes at the level of transparency and mobility potential. Moreover, it was established that the content of the programmes developed in the context of the project is similar to the existing ones; their differences relate to a difference of approach and overall learning objective of each of the programmes identified.

Bearing the aforementioned in mind and due to the absence of a credit system in Greece and the partial use of credits in some qualifications in Bulgaria in non-formal lifelong learning VET programmes, we adopted the logic of the ECVET credit system implementation, according to which 1 credit point is accumulated for every 25 hours of training. In addition, we used the ECVET qualifications and unit tables to break down the SEnDing training courses and translate the learning outcomes into credits accumulated at the end of each training program (Data Science and IoT).

For the work-based learning component of the two VET programs, planned to last for four (4) months per participant, we decided to consider 320 training hours, under the assumption that each participant would be involved for four (4) hours per working day (1 man month corresponds to 20 working days, which reads a total of 80 working days over the four-month period, leading to 320 training hours).

The adoption of the ECVET templates and tools, apart from providing a uniform method for presenting the two VET programmes, irrespectively of the particularities of each country, provides also the opportunity to all participants to have their newly developed knowledge, skills and competencies recognised in any context and country within the EU.

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

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