Equal class

Analysis and comparison of qualifications

Based on the 'ZOOM' approach

EQUAL-CLASS Project, Work Package 4

Engineers Qualified in Higher Non-University VET Institutions – Providing Arguments and Evidence for NQF/EQF Classification

This project has been funded with support from the European Commission and the Austrian Federal Ministry of Education and Women's Affairs (BMBF). The content of this publication reflects the views only of the author, and neither the Commission nor BMBF can be held responsible for any use which may be made of the information contained therein.

BMBF Bundesministerium für Bildung und Frauen

Lifelong Learning Programme

3s

Project Information:

Project title:	Engineers Qualified in Higher Non-University VET Institutions – Providing Arguments and Evidence for NQF/EQF Classification
Project acronym:	EQUAL-CLASS
Programme:	Lifelong Learning Programme, Leonardo da Vinci
Project number:	2012-1-AT1-LEO05-06968

Project coordinator: Monika Auzinger, auzinger@3s.co.at
3s Unternehmensberatung GmbH, Vienna, Austria

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Content

Analysis and comparison of qualifications. Following the ZOOM approach.

Executive Summary

EQUAL-CLASS is a European Commission-funded project which aims to analyse and compare qualifications in the field of **mechatronics, electronics/electrical engineering** across different countries, with particular focus on their **classification within National Qualifications Frameworks** (NQFs) and the **European Qualifications Framework** (EQF).

This report describes how the 'ZOOM' methodology was used within the EQUAL-CLASS project to compare qualifications from the field of mechatronics, electronics/electrical engineering between five partner countries: Austria, Germany, Switzerland, Lithuania and Portugal.

The description of qualifications was undertaken on the basis of a template originally developed in the ZOOM project (http://www.zoom-eqf.eu). This template was revised for the EQUAL CLASS project due to differing requirements. Alteration was necessary as EQUAL-CLASS pursues different objectives to the ZOOM project. Moreover, EQUAL CLASS faces a different starting position with regard to the development of the European Qualifications Framework (EQF) and the implementation of National Qualifications Frameworks (NQFs), as many NQFs have now been established or are currently in an early development stage. Many of the qualifications on which EQUAL-CLASS focuses have already been allocated to respective national NQFs.

The engineering qualifications from AT, DE, CH, LT and PT have been described using the new template, with each description consisting of three main sections - information on qualifications, qualification profiles, and evaluation process - and two optional sections - statistical indications and annexes. All qualifications studied in this report have been analysed and compared according to the three main sections of the template.

The comparison between qualifications was first undertaken on the basis of available information on the qualifications (input criteria). This demonstrated the primary differences between the qualifications, e.g. in terms of the age of graduates and the length of training. Nevertheless, comparison has shown that the majority of VET qualifications include elements of learning both at educational/training institutions and in the workplace (e.g. in enterprises). All analysed qualifications require compulsory attendance of the respective training programme.

The analysis and comparison of the qualification profiles shows quite different approaches towards the description of learning outcomes. In Switzerland, Austria and Lithuania work process orientation can be found, whereas in Germany learning process descriptors are the focus (learning fields approach). This made it difficult to map the different descriptions of each qualification within the two VQTS matrices, which consist of competence areas and steps

of competence development[1]. Nevertheless, it was possible to develop qualification profiles, e.g. for the selected qualifications in AT, CH and PT, which highlight the differences between the qualifications in terms of competence areas and steps of competence development.

With regard to evaluation processes, the comparison shows that in all of the qualifications examined in this study the assessment of competences is legally regulated and is executed by public bodies ('awarding bodies'). These 'awarding bodies' are responsible for (amongst other tasks): monitoring of how student competences are assessed; the quality assurance of the assessment of competencies and awarding of qualifications; and the organisation of assessment and awarding processes. In all countries, assessment of competences includes theoretical (written, standardised tests, written and/or oral examinations) and practical (workplace, workshops etc.) assessment stages. Appeal and resit of exams is possible in all analysed countries.

To summarise, the 'ZOOM template' was a useful tool for describing qualifications in a standardised manner although it was necessary to revise the original template due to the differing requirements and qualification context of the EQUAL CLASS project (particularly the advanced stage of NQF development).

Throughout the EQUAL-CLASS project, the project team used and tested **several different approaches to comparing qualifications**, focussing on non-academic higher qualifications in the field of mechatronics and electrical engineering/electronics, located between EQF levels 5 and 6. One of these was the theoretical-descriptive approach presented in this report, comparing qualifications from the perspective of learning outcomes.

Learning outcomes are considered a valuable tool in the comparison of different qualifications and in providing a 'common language' that is often referred to at European level. The work of EQUAL-CLASS has also demonstrated that in order to understand a foreign qualification, it is advisable to not only examine learning outcomes (descriptions), but also to consider other dimensions. EQUAL-CLASS attempted to do this by examining several different perspectives – see http://www.equal-class-eqf.eu/results/.

[1] The VQTS matrices - mechatronics and electrical engineering/electronics - were developed during two previous projects: VQTS I and VQTS II. More information on the NQTS model can be found at: http://www.vocationalqualification.net/.

1. Introduction

This report aims to summarise the activities and results of work package 4 - 'Analysis and comparison of qualifications' (based on the methodology developed in the 'ZOOM' project, http://www.zoom-eqf.eu/).

The aims of the work package are:

- Adoption of the ZOOM methodology for the comparison of qualifications in the sector of mechatronics, electronics/electrical engineering
- Comparison of qualifications from the field of mechatronics, electronics/electrical engineering between five partner countries, particularly in relation to classification within the National Qualifications Framework (NQF; if available or in development) and the European Qualifications Framework (EQF).
- Transfer of the ZOOM methodology to additional countries: Lithuania, Portugal and Switzerland.
- Transfer of the ZOOM methodology across sectors.
- Adaptation (if necessary) of the ZOOM methodology based on the results of its application to the new sector and the new qualifications.

Qualifications in the field of mechatronic, electronics/electrical engineering from five countries – AT, DE, CH, LT and PT - were described on the basis of a template adapted from the classification report of the ZOOM project. Subsequently, these descriptions, which are primarily based on curricula information and descriptions provided by the respective schools, were compared and analysed according to the categories of the template.

The most significant element of the work package was the adaptation and revision of the classification method contained in the ZOOM project report in order to meet the different aims and needs of the EQUAL-CLASS project and reflect changing circumstances (e.g. more countries, but still not all, have presented their National Qualification Frameworks [NQFs] since the completion of the ZOOM project). Therefore, the ZOOM methodology had to be adapted to serve the needs of the EQUAL-CLASS project. Feedback and recommendations related to the ZOOM methodology - the classification template for allocating qualifications to certain NQF/EQF levels and for comparing qualifications from different countries – are presented in this report.

2. Design and implementation of work package 4

The project partnership agreed on the following procedure to achieve the aims of work package 4:

a. Identify qualifications for comparison in the field of electrical engineering/electronics and mechatronics.

b. Collect basic information on the current stage of NQF development in AT, DE, CH, LT and PT (desk research).

c. Select one qualification per country and sector (if available) for comparison and analysis.

d. Describe selected qualifications from each country based on the modified ZOOM template (cf. annex 7.1).

e. Analyse and compare qualifications based on the modified ZOOM template.

f. Feedback and recommendations on the ZOOM methodology.

2.1. The ZOOM methodology

In the ZOOM project (http://www.zoom-eqf.eu/), a methodology for an objective and unambiguous classification of qualifications in respective NQFs was developed. The main element of the methodology is a template for the description of qualifications via the following sections:

- Information about the qualification
- Qualification profile
- NQF/EQF-level
- Information about the evaluation process
- Evaluation methods
- Expert consultation
- Statistical indicators (see: Template: http://ibw4.m-services.at/zoom/pdf/CRs/classification%20report_template.doc)

This template is the basis for the innovation transfer within the EQUAL-CLASS project. The template and the classification guidelines (or adapted versions thereof) developed in the ZOOM project were used for the analysis and comparison of qualifications in the field of mechatronics, electronics/electrical engineering.

2.2. Objectives of work package 4

The ZOOM methodology was developed within the ZOOM project: 'Building up mutual trust: Zooming in on EQF-level six with regard to the engineering sector´. The aim of ZOOM was to establish a common language and consensual basis for the description and classification of learning outcomes to improve mutual trust among the participating countries with regard to the classification of qualifications within the EQF. Furthermore, it was also designed to develop and operationalise the best-fit principle and to establish a standardised classification and referencing procedure to facilitate self-referencing and the classification of qualifications.2 The 'classification report´ for qualifications - the ZOOM methodology -was one of the main results of the project.[3]

The classification report contains information on the respective qualifications, qualification profiles, the respective NQF-/EQF-level, information on the evaluation process, evaluation methods, expert consultation, and statistical indications.

The ZOOM methodology (i.e. the classification report) was transferred and revised for use in the EQUAL CLASS project. Revision was necessary due to the different approach adopted by the EQUAL-CLASS project and because certain elements of the ZOOM classification report were no longer applicable (e.g. the expert consultation to identify the respective NQF/EQF level.)

[2] http://www.zoom-eqf.eu/; http://ibw4.m-services.at/zoom/pdf/about%20ZOOM/ZOOM%20in%20brief.pdf
[3] ibw4.m-services.at/zoom/pdf/CRs/classification%20report_template.doc

3. Basic information on NQF development

The following table provides a brief overview of the current stage of development and implementation of National Qualification Frameworks in AT, CH, DE, LT and PT based on the annual 'Analysis and overview of NQF developments in European countries' report (CEDEFOP, 2012)[4].

Table 1.1: NQF development in partner countries

Country	EQF Referencing Report[5]	Number of NQF Levels	Dimensions of descriptors	Legal documents	Current status
AT	Q2/2012	8	Knowledge/skills/competence	2009: adoption of the NQF position paper by the Council of Ministers.	Formal adoption
CH	-	8 (proposed)	Knowledge (declarative knowledge, understanding); skills (procedural skills, sensomotoric skills); and competences (vocational/professional competences and personal competence). Personal competence emphasises self-competence, social competence, and leadership competence	-	Development stage
DE	Q4/2012	8	Professional competence: knowledge, skills; Personal competence: social competence, autonomy		Formal adoption; early operational stage
LT	Q4/2011	8	Characteristics of activities (complexity, autonomy, changeability) and types of competence (functional, cognitive, and general); knowledge, skills, competence	Governmental resolution on the NQF was adopted in 2010 - legal and political basis for NQF implementation; two amendments of the law on education in 2011	Formal adoption; early operational stage
PT	Q2/2011	8	Broad categories of knowledge, skills, attitude	Decree No 782/2009 on the implementation of the NQF, in force since October 2010	Formal adoption; early operational stage

[4] CEDEFOP (2013); p.260ff.
[5] Presented at the EQF Advisory group meeting.

3.1. Identification of national qualifications for cross-country comparison

in the sector of electrical engineering/electronics and mechatronics

The following table provides a short overview of qualifications in mechatronics and electrical engineering/electronics on relevant EQF-levels 4, 5 and 6 in CH, DE, PT, LT and AT.

Table 1.2: National qualifications

Country	Electrical engineering / electronics, Mechatronics		
	Level 4	**Level 5**	**Level 6**
AT (proposal)	VET schools	*HTBLuVA* (VET college)	Bachelor's degree programmes
CH (no EQF referencing report available) (RLP based on EQF Level 5 and 6)	VET schools, apprenticeship training	Further Vocational Education *(Berufsprüfung (BP); Höhere Fachprüfung (HFP)*	*Dipl. TechnikerIn Höhere Fachschulen*, e.g. *Maschinenbau* *Dipl. TechnikerIn Höhere Fachschule*, e.g. *Systemtechnik* Bachelor's Degree Programmes
DE (proposal)	VET schools	Further Vocational Education *- Zertifizierter IT-Spezialist* *- Zertifizierter IT-Spezialist* *_ Geprüfte(r) ServicetechnikerIn*	*Staatlich geprüfte/r Techniker/in – Elektrotechnik, Mechatronik* (in future possibly called: Bachelor vocational) Bachelor's degree programmes
LT	Fitter and installer of electronic equipment Fitter and installer of mechatronic equipment	No qualifications available.	*Mechatroninių sistemų inžinierius* (Engineer of mechatronic systems)
PT	Apprenticeship courses	Technological Specialisation Courses (TSC)	Bachelor's degree programmes

4. Selection of national qualifications for cross-country comparison

Following the initial identification of qualifications, two qualifications from each of the five partner countries were selected for comparison and analysis through the modified ZOOM methodology.

The qualifications were selected according to the following criteria:

- Qualifications belong to the sectors or fields of activities of electrical engineering/electronics and mechatronics.
- Qualifications have already been allocated to NQFs, in a respective national level which has been referenced to EQF levels 4 or 5.[6]
- Qualifications are offered by the core partners (schools) in AT, CH and DE. In LT and PT, suitable schools and qualifications will be identified (and selected).

On the basis of these criteria the following qualifications were selected for description according to the modified ZOOM template (cf. annex 7.1), and subsequent analysis and comparison:

[6] Limiting the selection of qualifications to a single EQF level (e.g. level 5) was problematic due to the fact that in some countries (e.g. in Lithuania) qualifications in the engineering sector exist only in the workplace and are not provided by initial vocational training institutions.
For example, in Lithuania there are a number of different types of technicians and supervisors in the field of engineering and machinery production (equivalent to EQF level 5), but these individuals either acquired their qualifications more than 20 years ago (when higher vocational education schools provided such qualifications), or acquired them through ongoing training in the workplace (qualifications that are 'recognised' on the level of enterprise). Therefore, EQF level 4 qualifications were also added to the comparison and analysis of qualifications.

Due to the transitional period in referencing of qualifications to the NQFs and EQF, there are many cases in which the actual competences of qualifications that are 'institutionally' referenced to EQF level 4 should in fact be referenced to EQF level 5.

Table 1.3: Descriptions of selected qualifications

Coun-try	Sectors (fields of activities)	
	Electrical engineering / electronics	**Mechatronics**
AT	Graduate of *HTBLuVA* (VET college - diploma certificate), title 'Ing.' *(Ingenieur)* after 3 years' practical experience	Graduate of HTBLuVA (VET college - diploma certificate), title 'Ing.' *(Ingenieur)* after 3 years' practical experience
CH	*Dipl. Techniker HF, Systemtechnik* (i.e. degree in systems engineering)	*Dipl. Techniker HF, Maschinenbau* (i.e. degree in mechanical engineering)
DE	*Staatlich geprüfte/r Techniker/in – Elektrotechnik* (i.e. degree in electrical engineering)	*Staatlich geprüfte/r Techniker/in - Elektrotechnik (i.e.* degree in mechatronics engineering*)*
LT	*Automatinių sistemų eksploatavimo mechatronikas* (Mechatronic engineer of the exploitation of the automated systems)	*Mechatroninių sistemų inžinierius* (Engineer of mechatronic systems)
PT	*O Técnico de Eletrotecnia* Electrician technician (Et)	*Tecnologia Mecatrónica* Mechatronics Technology Specialist

5. Comparison and analysis of qualifications based on the ZOOM template

The following tables show a comparison and analysis of the qualifications submitted by the respective project partners. The descriptions of qualifications were produced using the adapted ZOOM template.

5.1. Information on the qualifications selected for comparison

Table 1.4: Information on the qualifications selected for comparison

	AT	CH	DE	LT	PT
TITLE OF THE QUALIFICATION (IN ORIGINAL LANGUAGE AND IN ENGLISH)	*Absolvent/in der HTBLuVA (Reife-und Diplomprüfungszeugnis), 'Ing.' nach 3 Jahren Praxis* Graduate of HTBLuVA (diploma certificate), title 'Ing.' after 3 years' practical experience	*Dipl. Techniker HF, Systemtechnik* (i.e. degree in systems engineering) *Dipl. Techniker HF, Maschinenbau* (i.e. degree in mechanical engineering)	*Staatlich geprüfte/r Techniker/n – Elektrotechnik* (i.e. degree in electrical engineering)	*Automatinių sistemų eksploatavimo mechatronikas* (Mechatronic engineer of the exploitation of the automated systems) *Mechatroninių sistemų inžinierius* (Operator of mechatronic systems)	*Técnico Especialista em Tecnologia Mecatrónica* (Mechatronics Technology Specialist) *O Técnico de Eletrotecnia* (Electrician technician)
FOCUS OF THE QUALIFICATION	Vocational education/training	Vocational education/training	Vocational education/training	Vocational education/training Higher vocational education	Vocational education/training
TRAINING PROGRAMME	Compulsory attendance	Compulsory attendance	Compulsory attendance	Compulsory attendance	Compulsory attendance
LENGTH OF TRAINING PROGRAMME *(if compulsory)*	5 years	3 years; a minimum of. 50% practical training at a qualified company and regular guided training in laboratories at the school. The education and training at *'Höhere Fachschule HF'* is based on the apprenticeship (dual education) system which lasts 3 to 4 years.	2 years (full-time) 4 years (part-time)	3 years when entering with basic education; 2 years when entering with secondary education. 4 years of study at the university of applied sciences.	Mechatronics Technology Specialist: 1560 hours; Electrician technician: 3100

PLACE(S) OF LEARNING	Vocational college, compulsory internship (minimum 8 weeks)	Classrooms and laboratories, and workplace learning in qualified companies	Vocational college	Initial VET schools and centres, apprenticeship in enterprises Universities of applied sciences	VET institutions and companies (internship)
ACCESS REQUIREMENTS FOR THE EVALUATION PROCESS[7]	Successful completion of lower secondary school	Successful completion of a relevant apprenticeship (dual education system in a technical field) which last 3 to 4 years.	3-year apprenticeship 1 year work experience	Evaluation process is launched only upon the completion of the initial VET programme / study programme and achievement of the foreseen objectives/learning outcomes assessed during the period of training. Evaluation process can also be accessed for the assessment of non-formal and informal learning.	
TYPICAL AGE RANGE OF THE LEARNERS	19 years old	Between 21 and 25 years old, depending on the number of years of relevant professional experience an individual possesses.	22 – 28 years old	22 years old	Mechatronics: 21-23 years old. Electrical engineering: 19-20 years old.
ACCESS TO NEXT LEVEL OF EDUCATION / TRAINING	Access to universities/ universities of applied sciences.	Access to Bachelor's studies at universities of applied sciences.	University entrance certificate.	1. Studies at higher vocational education colleges / universities of applied sciences aiming of achieving the degree of vocational bachelor. 2. Bachelor's studies at universities. 3. Continuing vocational training in enterprises with the aim of achieving a LTQF[8] level 5 qualification.	Students may apply for higher education courses via the special entry track, regulated by subparagraph b) of paragraph 2 of article 3 of the Decree-Law no. 393-B/99, of the 2nd of October. The training that they have already undertaken is accredited to

[7] Access requirements for beginning the training leading to the qualification evaluated in each country.
[8] LTQF = Lithuanian Qualifications Framework

				Studies at university: studies in the compensatory course (up to 1 year) to achieve university bachelor's degree permitting application to master's degree studies. Continuing vocational training in enterprises.	whichever higher education course they enter.
SECTORS / WORKING AREAS	Jobs in electrical/electronic engineering; Industry, public sector (all relevant fields)	Mechanical engineering (automation), electrical/electronic engineering, industry, public sector (all relevant fields).	Electrical engineering, programming, project and production planning, manufacturing and service industries, public sector, civil engineering industry.	Enterprises within industry, agriculture, energy sector, communications, health care, and transport sectors where he/she performs functions of assembly and exploitation of the automated mechatronic systems and their sub-systems (mechanical, pneumatic, hydraulic, electric, electronic and IT). Engineering production enterprises, transport and other sectors. The working areas: - Designing mechatronic systems - Installation, assembly and adjustment of mechatronic systems equipment - Exploitation of mechatronic systems. Organisation of engineering work and (related) business activities.	Areas of electronics, electricity, mechanics or automation.

5.2. Information on qualifications: Conclusions

1. A variety of titles of qualifications were identified in the partner countries, while mechatronics is explicitly mentioned only in the qualifications from Lithuania and Portugal.
2. The qualifications included in the analysis are provided by initial or continuous vocational education and training institutions in Switzerland, Germany, Austria and Portugal, and by VET and higher education institutions in Lithuania (EQF Levels 4, 5, 6).
3. All analysed qualifications require compulsory attendance of the respective training programme.
4. The length of the training programme varies between 2 and 5 years in all analysed cases.
5. Places of learning include: classrooms in schools; workplaces in enterprises; and universities of applied sciences *(only in Lithuania)*.
6. Requirements for access to the evaluation of learning outcomes acquired in the training process differ depending on the existing institutional VET models:
   - Completion of apprenticeship + work experience in the dual systems of Switzerland and Germany.
   - Completion of the school-based VET programme and practical training programme in the school based training programmes in Austria and Lithuania, as well as completion of study programmes in the universities of applied science in Lithuania.
7. The typical age of graduates differs considerably across countries: graduates are between 21-25 years old in Switzerland, are 19 on average in Austria, are between 22 and 28 in Germany, are 22 years old in Lithuania, and are 19-20 (for electrical engineering), and 21-23 (for mechatronics) in Portugal.
8. Acquired qualifications provide access to higher education in Switzerland, Austria, and Lithuania, and access to a university entrance certificate in Germany.
9. Workplaces and work processes in all of the analysed qualifications are related to engineering and the technical supervision of production processes.

5.3. Qualification profile

Table 1.5: Comparison of qualification profiles

	AT	CH	DE	LT	PT
1. Structure of the description of units	Profile is described by knowledge, skills, and competence. The units of qualification are defined by the processes of work and types of technological processes: **Mechanical engineering:** 1. Design and product development 2. Mechanics and calculation 3. Machinery and plants 4. Production technology 5. Automation technology 6. Robotics and process data 7. Laboratory 8. Workshop and production **Electronics / electrical engineering:** *1. Energy systems* *2. Drive technology* 3. *Industrial electronics*	Profile of qualification consists of 3 main elements: working fields, units of qualifications, and competences. Example of **mechanical engineering (design technology) and systems engineering:** Working fields: 1. General fields (the same for both qualifications): leadership, management, knowledge management. Units of qualification, e.g. leadership: lead employees, make decisions, planning and managing projects, effective presentation and communication. 2. Engineering - **mechanical engineering**. Units of qualification: develop products, construct and assemble machines, lead production, operation and maintenance of technical facilities. 3. Engineering - **systems engineering**. Units of qualification: Systems engineering, configuring and projecting a system, system networking, building of systems and putting them into operation, maintaining and renewing systems	Qualifications are described in terms of learning fields consisting of the knowledge and skills from the different subjects. Examples: **General obligatory learning field:** Work psychology **Obligatory learning fields of electrical engineering**: -Production management processes -Chemistry and materials -Electronics -Electrical engineering -Physics -Information technologies -Measuring technologies **Optional learning fields**: -IT supported measuring technologies -Mechatronic systems -Development of mechatronic systems -Adjustment technologies -Control equipment -Automation equipment -Electric machines and equipment -Electric generation equipment -Energy equipment -Monitoring electronics -Electromagnetic compatibility -Telecommunications -Transmission technologies -Software equipment	Qualification described in terms of units of qualifications and competences. Examples: ***Mechatronic operator for the exploitation of automated systems*** Units: -Assembly, adjustment, regulation, and exploitation of the mechanical equipment. -Assembly, adjustment, regulation, and exploitation of the pneumatic equipment. -Assembly, adjustment, regulation, and exploitation of the hydraulic equipment. -Assembly, adjustment, regulation, and exploitation of the electric and electronic equipment. -Adjustment, regulation, and exploitation of sensors and monitoring systems. -Adjustment, regulation, and exploitation of control systems. The units are described by integrating different work processes related to the **type of technology or equipment.** ***Engineer of mechatronic systems*** Units:	Contextualised description of the application of knowledge, skills, and competence in execution of work processes and functions typical for the unit of qualification. Examples of units: -Machinery and electrical installations -Programmable logic controllers -Digital systems -Electronics -Microprocessors / microcontrollers -Computer numerical control -Computer aided design

			-Network technologies -Databases -Internet technologies -Microcontrol technologies -Industrial design -CAD and CAE -Equipment of circuitry -Work safety -Environment protection and quality assurance -System administration -Communication technology -Mathematical methods of electronics. -Data processing equipment -Project work -Technical English language -Vocational pedagogy	-Designing and updating of mechatronic systems -Installation, assembly, and adjustment of the equipment of mechatronic systems -Exploitation of mechatronic systems -Organisation of engineering activities and business.	
2. Contents of the elements of qualifications	Combination of subject and work process orientation. The units of mechanical engineering are more oriented towards the acquisition of theoretical knowledge and its application, while the content of electrical/electronic engineering is described in terms of work process oriented competences (examples) : **Mechanical engineering (Automation)** The students obtain a profound knowledge of the composition and function of machinery, devices, and assemblies which they have acquired in theory and practice in the following subjects: design	Clear work process orientation in describing units of qualifications and competences. Example: **Unit of qualification:** **Make decisions** Graduates are within their mandate responsible and able to make independent decisions. They are expected to make decisions based on factual information and with sufficient justification. **Competences:** - deliberately use different sources of information such as: literature; documentaries; the internet; libraries; and patents. - apply appropriate analysis and reasoning methods to the criteria for decision making. - in addition to technical aspects also take into account social, ethical, environmental and other	The learning fields are defined in a holistic manner and encompass the sets of knowledge and skills required in the indicated field. The knowledge and skills for each learning field are drawn from the different subjects. Example: **Learning field:** To develop switching networks. **The aims of the learning field:** The students can apply basic rules of Boolean algebra to develop switching networks and assess their function. They are able to specify the behaviour of basic logic linkages with appropriate tools. Students create and present the functional equations and perform optimisations according to task. They become familiar with basic function blocks of the	Contents of the units and competences are in principle based on the work process. Example: Mechatronic operator for the exploitation of automated systems **Unit:** Assembly, adjustment, regulation, and exploitation of mechanical equipment. **Competences:** - To recognise, define and apply the elements of mechanical systems. - To assemble, adjust, and regulate mechanical equipment. - To exploit mechanical systems. **Engineer of mechatronic systems** **Unit:** Designing and updating of mechatronic systems	Content of the units are described via knowledge, skills, and competence in the execution of work processes and functions typical for the unit of qualification. Example: Unit: Machinery and electrical installations - Identify the features and operation of machinery and electrical equipment often found in industrial plants. - Identify the basic principles on electrical installations. - Identify and apply safety standards which must be met for intervention in electrical installations. - Characterise the operation of direct current electrical machines and their applications

	and project management, technical mechanics and calculation, production technology, machinery and plants, automation technology. **Electrical / electronic engineering** Students are able to construct electro-technical systems by assembling mechanical, electrical, electro-technical, and IT components. Students can run electro-technical systems, diagnose malfunctions and repair interruptions while applying appropriate measuring, testing and diagnostic techniques.	relevant factors. **Unit of qualification:** **Develop products** **Competences:** - begin with an engineering overview and analyse developments in the relevant aspects of the planned products. The results are described in a functional specification. - plan the development steps for the market-driven solution and application of the product. - design the product according to the current technical possibilities with components and materials to ensure that correct technical performance. - consider issues of product safety, reliability and ergonomics when in use.	combinatorial logic, and using these develop complex switching networks and ensure a modular circuitry. The students test the developed switching networks through software simulation or a real circuit. **Contents (subjects):** -Basic logical links -Basics of Boolean algebra -Creation of logical equations in -disjunctive and conjunctive normal forms -Minimisation method -Functional basics of combinatory logics -Design methods in the development of switching networks	**Competences:** Includes analysis of the effectiveness of mechatronic systems and the need for the updating of these systems, and designing of the schemes of mechatronic systems. This unit also includes establishment of the common design (construction) of the system, the design of the control programmes (software), and the preparation of the technical documents.	- Recognise electrical equipment technology, the rules to observe on the execution of assembly, and safety standards and regulations for each type of facility. - Identify maintenance procedures and the most common equipment malfunctions. - Plan equipment and systems in complex situations. - Assist one's supervisor in order to contribute to/support the modernisation of the units. - The ability to collaborate with R&D department. - Operate in a maintenance capacity, elaborating/ implementing the maintenance plans to prevent and correct mechatronic equipment flaws/malfunctions. - Maintenance of digital systems, and the use of applied technology
3. Mapping the units of qualification within the VQTS matrix	Units of qualification match the final steps of competence development in the all competence areas of the competence matrix for mechatronics. Units of qualification match two steps of competence development in 2 competence areas of the competence matrix for electronics/ electrical engineering.	The contents of the qualification in mechanical engineering (design technology) is significantly broader than the contents covered by the competence matrix for mechatronics in terms of the **field of activity and the objects of work.** Therefore, the mapping of the units of qualification demands a clarification of the relationship between the contents of	The competences indicated in the training plan address all the competence areas and competence development steps indicated in the competence matrices. However, the sequence of competence development in the curricula do not necessarily follow the logic of the steps of competence development indicated in the competence matrix, since	With regard to the 'mechatronic operator for the exploitation of the automated systems' qualification, at best the units of qualification fit only within one competence area of the competence matrix for mechatronics: **Installing and adjusting mechatronic components in**	The qualification "Técnico Especialista em Tecnologia Mecatrónica matches the competence areas of the respective VQTS Matrix. The qualification profile shows that the qualification matches from the second to third to fourth step of competence development. Only in competence area 7 - '**Installing, configuring, programming and testing**

	Competence area: **Supervising and supporting work and business processes including quality management** Step of competence development: He/She can evaluate the results of process monitoring with software tools and determine quality assurance actions (work, production, and time schedules). Competence area: **Diagnosing and repairing of electrical/electronic systems and equipment** Step of competence development: He/She can select and use diagnostic methods for complex electrical/electronic systems and carry out preventative measures for the avoidance of disturbances and malfunctions in communication with customers (e.g. detection of bit error rate, overvoltage protection analysis).	mechanical engineering (as it is treated in the descriptor of the qualification / curriculum) and mechatronics in the competence matrix. With regard to the units and competences, certain similarities and equivalencies can be identified with the steps of competence development in the matrixes of mechatronics and electrical engineering.	curricula are based on the didactical principles of training.	**systems and production lines.** The match between the steps of competence development and units of qualification is somewhat approximate. For the 'engineer of mechatronic systems', the units of qualification according to the complexity of activity / work process can be mapped to the competence matrix Electronics / Electrical Engineering (competence areas : **4. Designing, modifying and adapting wirings and circuit boards for electrical and/or electronic systems including their interfaces. 5. Developing custom designed electrical and/or electronic projects. 8. Diagnosis and repair of electrical/electronic systems and equipment.** However, some of the contents of the units of this qualification fit better with the competence matrix of mechatronics, particularly the following competence areas: **4. Designing, adapting, and building mechatronic systems and facilities on the basis of client needs and site plans. 7. Installing, configuring, programming, and testing hardware and software components for control and**	**hardware and software components for control and regulation of mechatronic systems and facilities'** - does the qualification match the final step of competence development: He/She can develop, test, and configure hardware and software solutions for networked mechatronic systems; and can monitor system conditions with suitable measuring and visualisation tools. The qualification O Técnico de Eletrotecnia also matches the competence matrix. In the case of this qualification the first, second, and third steps of competence development can be matched

			regulation of mechatronic systems and facilities **9. Diagnosing and repairing malfunctions with mechatronic systems and facilities, advising clients on avoiding malfunctions, and modifying and expanding mechatronic systems.**

Example: Comparison of selected qualifications based on the VQTS Matrix ‘Mechatronics’.[9]

[9] Colours of qualifications profiles:

PT

CH

AT

VQTS II Competence Matrix 'Mechatronics'						
Competence Areas (core work tasks)	**Steps of Competence Development**					
1 **Maintaining and assuring the reliability of mechatronic systems**	He/She can perform basic scheduled maintenance on mechatronic machines and systems and adhere to equipment maintenance plans.	He/She has mastered the maintenance procedures for mechatronic systems such as the use of service documents and maintenance plans and, if faced with new challenges, can make necessary adaptations.	He/She can use preventive maintenance to assure the trouble-free operation of mechatronic systems. In addition, he/she can modify operational sequences to implement quality-assurance measures.	He/She can develop the necessary procedures for the maintenance of mechatronic devices and systems, and can schedule maintenance and quality-assurance procedures.		
2 **Installing and dismantling mechatronic systems and facilities**	He/She can use written instructions to install and dismantle individual components (sensors, actuators, drives, motors, transport systems, racks) that form a functional group of mechatronic systems.	He/She has mastered the installation and dismantling of mechatronic systems that use several technologies (mechanics, hydraulics, pneumatics, electrical-mechanics, electronics), is able to set up connection technology, and can assess the efficiency of the overall system.	He/She can provide independent mechatronic solutions for the construction of production lines, assure their overall functionality, and, in addition, can use both existing and modified standard components.			
3 **Installing and adjusting mechatronic components in systems and production lines**	He/She is able to install and adjust standardised mechatronic components, e.g. individual electro-pneumatic valves, sensor and actuator units.	He/She can install and adjust components of mechatronic subsystems (e.g., linear drives, measuring systems, transport systems).	He/She can install and adjust complex mechatronic facilities that include diverse technologies and instrumentation and control (I&C) equipment, adjust the associated parameters, test the facilities overall functionality, and assure their reliability			
4 **Designing, adapting, and building mechatronic systems and facilities on the basis of client needs and site plans**	He/She can use machine tools controlled either manually or via a computer-program to fabricate (according to production designs and customer requirements) the individual components for mechatronic systems. He/she can provide simple designs and descriptions of mechatronic subsystems and can use basic CAD applications.	He/She can build simple mechatronic subsystems through the use of engineering drawing and can install the devices according to specific production needs. He/She can act on an extensive knowledge of standards and regulations (e.g. on surface treatments) and is able to use CAD's more advanced functions (e.g. interference check).	He/She can build mechatronic systems by using both original construction techniques and previously designed parts. He/She fully understands CAD functions and can document system developments (parts lists, descriptions of function, operating instructions).	He/She can design and build autonomous mechatronic subsystems and, with suitable measuring and testing facilities, can assess the necessary production accuracy. He/She can document the results with quality-control systems.	He/She can make independent adaptations to the various devices (including selection of drives, sensors, PLC) and can use CNC programs for building the system. He/She can, through a digital mock up, assemble and simulate the functioning system and use computer-aided computations (e.g. FEM). He/She is able to perform cost-benefit analyses (e.g. as a basis for deciding whether components should be bought or individually constructed.)	He/She is able to independently develop complex mechatronic systems and can calculate the economic usefulness of the system. He/She can optimise CNC programs for the manufacture of complex mechatronic devices and systems, and monitor the automated quantity of an open loop control system.
5 **Putting mechatronic systems into operation and providing clients**	He/She can, according to specifications and blueprints, put mechatronic devices into operation and provide support	He/She, following considerations of an enterprise's needs and basic conditions, can put mechatronic systems into	He/She, following consideration of all basic conditions, can master the establishment of interconnected mechatronic	He/She can evaluate customer requirements for mechatronic facilities, develop solutions, and can plan	He/She can direct, including scheduling and time management, the establishment of the project	

with technical and economic support	to the client in the hand-over phase.	operation, create the necessary documentation, advise the customer on safe operation of the devices, and advise on future technology selection.	systems and machines, and can provide the necessary documentation including a manual. He/She can review client needs and configure machines that provide solutions. He/She can train the customer where necessary and provide support for safe operating procedures.	system implementation and operation.	from the creation of a proposal to client acceptance.
6 Supervising and evaluating both the process sequences of mechatronic systems and facilities and the operational sequence (including quality assurance)	He/She can supervise process sequences according to specifications as well as implement any requested quality-control measures.	He/She is able to independently supervise the process sequences, evaluate the results, operate an accompanying statistical process control (SPC) for the quality control plan, and prepare simple work schedules, including production schedule and time management.	He/She can operate and supervise mechatronic facilities, choose testing and monitoring plans, establish the accompanying SPC, seek optimal results of the production line according to material-flow, and provide work schedules including standard production times.	He/She has mastered the monitoring of complex mechatronic systems using virtual instruments and PPS systems as well as open loop control for the optimisation of machinery arrangement, material flow analysis, and scheduling.	He/She is able to optimise the process cycles of mechatronic production lines, provide instructions on modifying the PPS systems (e.g. adjustment to SAP systems), and introduce quality systems for continuous improvement processes (CIP/KVP).
7 Installing, configuring, programming and testing hardware and software components for control and regulation of mechatronic systems and facilities	He/She is able to install and configure programs for hardware and software components as well as set up simple programmable logic control programs (PLC).	He/She has mastered the selection of hardware and software for mechatronic systems (sensors, actuators, interfaces, communication procedures) and can provide and test simple programmable logic control programs (PLC) according to production process requirements.	He/She can integrate and configure program-, control-, and regulation-mechanisms in mechatronic systems, program simple devices (in co-operation with developers), and simulate the program sequence before start-up.	He/She is able to develop, test, and configure hardware and software solutions for networked mechatronic systems, and can monitor system conditions with suitable measuring and visualisation tools.	
8 Preparing and distributing the technical information for adjustment of each enterprise's mechatronic systems	He/She can provide descriptions and designs of mechatronic subsystems and is familiar with basic CAD applications.	He/She fully understands the management of technical information documents for mechatronic systems and can prepare and adapt these documents according to an enterprise's specific operating requirements.	He/She is able to analyse complex operational sequences separately in order to understand the connections and develop maintenance and production procedures. He/She understands that system parameters are important for equipment functions and can independently assess and document the wear and general condition of the mechatronic equipment.		
9 Diagnosing and repairing malfunctions with mechatronic systems and facilities, advising clients on avoiding malfunctions, and modifying and expanding mechatronic systems	He/She can diagnose and repair errors and malfunctions in simple components and devices in mechatronic systems. He/She is able to use the necessary assessment, measuring, and diagnostic tools.	He/She is able to independently correct problems in mechatronic production equipment with the help of (computer-aided) diagnostic systems and the use of expert systems, databases, and error documentation.	He/She can diagnose and repair errors and disturbances in complex mechatronic equipment and is able to advise clients on how to avoid sources of malfunctions through changes or upgrades in the equipment and system.	He/She is able to develop, through analyses of malfunctions in mechatronic equipment, a monitoring and diagnostic system	

5.4. Qualification profile: Conclusions

1. The structure of the compared profiles of qualifications in most cases consists of 2-3 hierarchical-structural elements based on the learning outcomes or competences: in Switzerland, the profile of the qualification consists of working fields, units of qualifications, and competences; in Austria, the profile is described via knowledge, skills, and competence; in Lithuania by units of qualifications and competences. Only in Germany is there stronger input orientation in the structure of profiles - qualifications in the curriculum are described in terms of learning fields consisting of the knowledge and skills from the different subjects.
2. The analysis of the contents of the units of descriptors and learning outcomes reveals a higher or lower degree of work process orientation in the descriptors of Switzerland, Austria and Lithuania, and a learning process orientation in the German descriptors. Work processes are clearly defined in the profiles of Switzerland. With regard to the qualification profiles of Austria, there is a mix of subject and work process orientation, because the units of mechanical engineering are more oriented towards theoretical knowledge and its application, while the contents of electrical/electronic engineering are described in terms of work process oriented competences. In Germany, the learning fields are formulated in a holistic manner and encompass the sets of knowledge and skills for the indicated field drawn from the different subjects. In the Lithuanian profiles, the units of qualifications are described by integrating different work processes related to the specific type of technology or equipment.
3. The mapping of the units of the analysed qualifications to the VQTS matrix is far from a smooth and unequivocal process. In some cases, the contents of a qualification in terms of the field of activity and objects of work is broader than the content covered by the competence matrix. For example, the contents of qualification of the *Dipl. Techniker HF, Maschinenbau* degree in mechanical engineering (design technology) from Switzerland covers significantly more ground than the competence matrix for mechatronics. The qualification profile from Austria matches the final steps of competence development in all of the competence areas of the competence matrix for mechatronics, and for two steps of competence development in the two competence areas of the competence matrix for electronics/electrical engineering. It is very difficult to match the qualifications profile from Germany to the competence matrices, because the sequence of competence development in the German curricula is based on the didactical principles of training and does not necessarily follow the logic of the steps of competence development. The match between the steps of competence development of the competence matrices and the units of qualification is also somewhat imprecise in the case of qualifications profiles from Lithuania. For example, in the profile *Mechatronic operator for the exploitation of automated systems,* the competences are more focussed on several work processes corresponding to the competence development step 'Installing and adjusting mechatronic components in systems and production lines'**.** With regard to the 'engineer of mechatronic systems' qualification however, certain units of the qualification can be matched to the competence matrix for

mechatronics and others to the competence matrix for electronics/electrical engineering.

5.5. Evaluation process

Table 1.6: Comparison of evaluation processes

Compared features of evaluation process	AT	CH	DE	LT	PT
LEGAL BASIS FOR EVALUATION PROCESS *(if available)*	Result assessment decree - Leistungsbeurteilungs-verordnung http://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10009375 Examination regulations- Prüfungsordnung BMHS http://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20000430	- *'BBG'* law of professional education - *'Mindestverordnung MiVo'* - *'Rahmenlehrplan RLP'* - several SBFI[10] guidelines	Vocational Training Act *(‚Berufsbildungsgesetz')* of 23 March 2005 (BGBl. I S. 931), with the amendment of December 2011 (BGBl. I S. 2854)	The Law on Vocational Education and Training (1996) defined the main functions and institutions responsible for the evaluation process, delegating this responsibility to the representatives of employers (Chambers of Commerce, Industry and Crafts). The Law on the Amendment of the Law on Vocational Education and Training (2007) introduced the Lithuanian Qualifications Framework and opened up access for assessment to the different competent bodies. The order of the Minister of the Education and Science concerning approval of the descriptor of the order of assessment of acquired competences issued on the 11th of December 2012 No. V-1710	Technological specialisation courses (TSC) established by Decree-Law no. 88/2006, of the 23rd of May
NAME OF THE QUALIFICATION AWARDING BODY	*BMUKK* - Ministry of Education, Arts, and Culture	- *SBFI* (State Secretariat for Education, Research, and Innovation) - *BKS Kanton Aargau* (*Departement Bildung, Kultur und Sport - Berufsbildung und Mittelschulen*)	Bavarian Ministry of Education and Science Supervision of schools at the government of Franconia	Vocational qualifications are awarded by the Ministry of Education and Science. The assessment of competences is carried out by competent awarding bodies that must be licenced by the Ministry of Education and Science. The licence is issued following an	At school and at macro level the Ministry of Education (ME) through the Directorate General for Education (DGE, Direcção-Geral da Educação) is responsible.

[10] State Secretariat for Education, Research and Innovation.

		- *VERITAS* ISO 9001:2008, EduQua, ISO 29990:2010	Hesse Ministry of Education in Wiesbaden; Dep.III	evaluation of the competence of a candidate institution. The primary assessment provider is still the Chambers of Commerce, Industry and Crafts, responsible for the organisation of the final examinations leading to the award of a qualification. In higher vocational education the assessment of competences and awarding of qualifications is delegated to the universities of applied sciences.	The National Agency for Qualification (ANQ) co-ordinates evaluation and assessment activities in the vocational education and training area.
TYPE OF INSTITUTION	Public	Private with public access and order of the government	Public	Public	Public
TASKS OF THE AWARDING BODY IN RELATION TO THE QUALIFICATION DESCRIBED	Annual evaluation process including students, teaching staff, and management, production of a quality report, and management and performance review.	Eight feedback programmes with students, teachers, employees, and employers. In order to control the performance and results according to the regulations and requirements established by the government. Annual evaluation and reports. Quality reports, management and performance reviews. Performance reporting to the government (Bildungs- und Kulturdepartement).		Ministry of Education and Science: 1. Defines the procedures and rules for the assessment of competences. 2. Accredits the bodies responsible for the organisation of the assessment of competences. 3. Supervises the process of assessment of competences. 4. Awards qualifications. Competent body of assessment (Chambers of Commerce, Industry and Crafts): 1. Prepares the tasks for the theoretical and practical tasks of final examination. 2. Organises the assessment process (theoretical and practical examinations) and ensures its quality.	Contribution to curriculum development/adjustments, evaluation/assessment (school self-assessment, Teacher appraisal and student assessment).
OTHER INSTITUTIONS RELEVANT TO THE QUALIFICATION DESCRIBED	ARQA-VET: Assists with the Quality Initiative in VET: QIBB – QM-System of Austrian vocational schools and colleges, HTL-Q-SYS = special	Periodic accreditation of the whole school and courses of study by SBFI/BKS. Peer review by external peers from VERITAS.	TÜV Rheinland Cert GmbH (an independent inspection organisation) Schulinspektion des Landes Hessen (school	The Centre for Development of Qualifications and Vocational Education and Training executes the functions of coordination and supervision of the national system of qualifications, and also supervises the process of awarding	Ministry of Education, Directorate General for Education; Directorate General for Human Resources in Education (DGRHE); the Directorate General for

	issue for technical institutes. https://www.qibb.at/ http://www.htl.at/de/htlat/qualitaet/htl_q_sys.html ARQA-VET also organises peer reviews by external peers.	All other (about 40) Höhere Fachschulen Technik HF schools in Switzerland.	inspection for the state of Hesse)	of qualifications. This institution also provides methodological support for the Chambers in the designing of assessment tasks and organisation of examinations.	Innovation and Curricular Development (DGIDC); the Financial Management Office (GGF); the Office for Education Statistics and Planning (GEPE); the Information System Co-ordinating Office (MISI); the Office for Educational Evaluation (GAVE); the National Agency for Qualification (ANQ); the Scientific and Pedagogical Council for Continuous Training (CCPFC); and the General Inspectorate of Education (IGE); The Office for Educational Evaluation (GAVE); and The National Agency for Qualification (ANQ)
DESCRIPTION OF EVALUATION PROCESS	For the higher vocational schools, new assessment regulations are currently being developed for the diploma (graduation) thesis. In the future this diploma thesis will have to be presented by teams of between 2 and 5 candidates in written form, with a maximum volume of 80 pages and established quality criteria. This diploma thesis will form an integral part of assessment and will have to be presented to the examination panel and defended before	Assessment of the competences including knowledge at the end of each term and a final assessment consisting of a written and oral diploma examination including presentation of the diploma thesis in the form of open questions.	Continuous Evaluation during the studies – a minimum of two written tests in each subject. At the end of the course candidates take final written examinations in four special subjects (chosen by the students); A separate final examination in order to obtain university entrance.	The evaluation process consists of continuous assessment throughout the studies (examinations of subjects) and a final evaluation. Theoretical examination is carried out through a written test. Theoretical examination tasks cover all the fields of activities of mechatronics foreseen in the VET standard. Practical examination is organised in the workshop of the VET school or sectoral training centre. Practical tasks must include the assessment of at least two core competences foreseen in the VET standard: to assemble, fit and adjust pneumatic equipment; to assemble, fit and adjust hydraulic equipment;	The Ministry develops detailed national programmes to implement the national curriculum, including guidelines for schools on how to develop student assessment criteria. Similarly, the Office for Educational Evaluation (GAVE) develops assessment tools for teachers to use at their own discretion.

	candidates can pass the written examination.			to assemble, fit and adjust electric and electronic equipment; to assemble sensors , to fit and adjust monitoring systems; to assemble, fit and adjust control systems; Also, the task must include at least one of the remaining competences. Practical examination includes assessment of key skills.	
EVALUATION CRITERIA		Certified QM-System 8 Feedback programmes with students, teachers, employees and employers. Regular classroom visits. Learning output confirmed with through official documentation such as RLP, MiVo, BBG. Curriculum Qualification of the school Management. Qualifications of teachers. Several Feedbacks means like from students, teachers, employees, companies, Auditors a.s.o.	Defined by Fachschulordnung (FSO): 6 grade system Pass: grade 1 – 4 Fail: grade 5 + 6.	Knowledge is assessed through the use of a 10-grade system. The lowest satisfactory grade is 4. Practical skills are assessed by applying criteria of work performance and quality specific to the performed activity.	Student learning objectives are guided by national programmes for each subject area and each cycle.
EXAMINERS	The final examination is supervised by the commission with the participation of teachers and one external assessor (from other schools, the ministry etc.).	The final examination includes the participation and assessment of external professional experts from qualified companies that are highly qualified in both the relevant diploma topics and technical fields.	Examination board consists of the educational staff.	The commission of final examination consists of representatives of employers and vocational teachers.	Internal school teachers and external teachers.
POSSIBILITIES OF APPEAL (possibility to appeal the results of evaluation)	Possibilities for appeal are provided.	1. Board of the school (Schulrat) 2. Possibility to appeal the results of evaluation overseen by *SBFI/BKS* or by *EK-HF* (*Eidg, Kommission*	Are defined by the Bavarian and Hesse Ministry of Education	Possibilities for appeal are foreseen in the order of the Minister of the Education and Science concerning the approval of the descriptor of the order of assessment of acquired competences issued on the 11th of December 2012 No. V-1710	Should a student feel that he or she has been treated unfairly in the evaluation process, it is possible to appeal to the school, which will carry out an assessment of the

		der Höheren Fachschulen)		When disputes and disagreements arise concerning the order of the assessment process, or the results of an assessment, the written objections and appeals of participating individuals are accepted by the commission of objections established by the assessment institution. The appeal must be presented in a maximum of 2 days after the availability of assessment results.	individual case. Should this assessment find in favour of the student, a new exam will take place.
REPETITION OF (PARTS OF) THE EVALUATION PROCESS	Failure to achieve the required level, or a negative assessment within the thesis or written examinations leads to the repetition of the respective examination.	A maximum of one repetition is possible.	One repetition is possible.	Repetition is possible only in exceptional cases.	Should a student fail to pass the exam(s), it is possible for that student to resit the exam in order to attempt to pass the second time.
EVALUATION METHODS	Tests, written exams, practical tasks in the workshops, thesis.	A written and an oral diploma examination including presentation of the diploma thesis in form of open questions.	Tests are newly designed each year by the local teachers and reviewed by the government.	Assessment of knowledge: standardised written multiple choice tests or open written tasks. Assessment of practical skills: practical tasks executed in the workshops.	A formative assessment (allows examiners to obtain information about the development of the apprenticeship) and a summative assessment (as a basis for final certification).

5.6. Evaluation process: Conclusions

1. In all countries, the assessment of competences is regulated though legislation by legal acts and laws at the national level. The implementation of these legal norms is ensured by the different specific legal acts and regulations enacted and the relevant provisions followed by the delegated institutions and bodies.
2. In Austria and Lithuania, the primary awarding bodies are the central ministries related to education. In Switzerland and Germany, this role is delegated to institutions of regional government.
3. The award of all analysed qualifications is executed by public bodies.
4. In all the examples analysed the tasks of awarding bodies are quite similar and they include: a) monitoring of how students' competences are assessed; b) quality assurance of the assessment of competences and awarding of qualifications; c) organisation of the assessment and awarding processes.
5. In Switzerland, Austria and Germany the assessment of competences and awarding of qualifications involves the participation of both different quality management and assurance agencies working in the engineering sector, and external peers such as VET providers and school inspectors. In Lithuania, the management of assessment at the national level is supervised and methodologically supported by the expert public body – the Centre for Development of Qualifications and Vocational Education and Training.
6. The assessment of competences in all countries includes theoretical and practical assessment stages. The assessment of knowledge is undertaken in the form of written standardised tests, written tasks, or oral examinations. The assessment of practical skills takes place in workplaces (in the case of apprenticeships) or in school workshops.
7. In all analysed countries there are possibilities for appeal and repetition of examinations.

5.7. Feedback and recommendations on the ZOOM methodology

The EQUAL-CLASS project aims to transfer the methodology (template) developed to describe qualifications within the ZOOM project across sectors and to the national contexts of CH, LT and PT.
Moreover, the current project aims to adopt the ZOOM methodology for the comparison of qualifications in the sector of mechatronics, electronics/electrical engineering and to adapt it based on the findings of the study to make it applicable to new sectors and qualifications.

'Within the LLP project ZOOM, a methodological approach was developed to support an objective and unambiguous classification of qualifications within the respective NQFs. The template and the classification guidelines (or slightly adapted versions thereof) developed in the ZOOM project will be used for the analysis of qualifications in the field of mechatronics, electronics/electrical engineering and their classification in the NQF/EQF. Additionally, the Competence Matrices for 'Mechatronics' and 'Electronics/Electrical Engineering' developed in the VQTS projects (www.vocationalqualification.net) will also be used for comparing qualifications and identifying the appropriate NQF/EQF levels.' (project proposal, work package 4)

This report presents the activities and findings of work package 4 of the EQUAL-CLASS project. Additionally, it was deemed necessary in work package 4 to make several changes and adaptations to the ZOOM methodology (template to describe qualifications) in order to account for developments in the advancement of NQFs in recent years. These changes and adaptations will be described in the following sections. All sections (of the ZOOM template) that are not mentioned below have been integrated into the EQUAL-CLASS template without changes.

5.7.1. Section 1: Information about the qualification[11]

The following information is requested within the EQUAL-CLASS template and has been added to the original to the ZOOM template:
- Length of training programme (if compulsory)
- ISCED level (1997)
- EQF level (if applicable, based on the EQF referencing report)

5.7.2. Section 2: Qualification profile

This section has been expanded for the EQUAL-CLASS project. The qualification is now described through three perspectives: units of learning outcomes; knowledge-skills-competences (learning outcomes per se); and work processes and competence profiles based on the previously developed VQTS matrices for mechatronics and electrical

[11] The numbers of the respective chapters belong to the ZOOM template.

engineering/electronics. Therefore, different sets can be used for the descriptions of learning outcomes, which is necessary due to the fact that different kinds of learning outcomes descriptions are available in different countries.

Furthermore, the previously developed VQTS matrices have been included as another basis on which to compare qualifications within the same sector, e.g. mechatronics or electrical engineering/electronics, from different countries.

5.7.3. Section 3: NQF-/EQF-level

This chapter, which was significant within the ZOOM project, has been completely revised for the EQUAL-CLASS project. This was necessary due to the differing conditions of NQF/EQF development processes. When the ZOOM project was carried out, the majority of EU member states had only begun to develop their NQFs, and only a small number of EQF referencing reports were presented at the EQF Advisory Group throughout the duration of the project[12].

In contrast, when the EQUAL-CLASS project began, just one year after the completion of the ZOOM project, a large number of countries had already presented their EQF referencing reports and national NQF development processes had progressed significantly. While not all countries had finalised their NQFs or allocated all qualifications to NQF levels, far more information was available on the topic of the allocation of qualifications to certain levels. Consequently, the starting points for the two projects were quite different.

This also has had an effect on section 6 of the ZOOM-template - the expert consultation. In one sense, these expert consultations have already been conducted by Member States in order to prepare for the allocation of qualifications, e.g. Germany has conducted several working groups consisting of sectoral experts which provided their recommendations concerning the allocation of the respective qualifications to certain NQF-levels.[13] Therefore, it was no longer necessary to conduct expert consultation as part of the EQUAL-CLASS project. The project partnership could build on results that have been achieved in other contexts.

5.7.4. ZOOM: Conclusions

Some of the elements of the ZOOM method remain valid and can be used in various contexts to describe qualifications in an objective and unambiguous manner. But the objectives of the template - to support an objective and unambiguous classification of qualifications within respective NQFs based on arguments substantiated by details provided on the evaluation process of a qualification, results from expert consultation, and additional statistical indications supporting the classification suggestion - can be difficult to achieve in different contexts with other surrounding conditions.

[12] http://ec.europa.eu/eqf/documentation_de.htm (26.07.2013)
[13] http://www.deutscherqualifikationsrahmen.de/de/expertenvoten/?s=RM1eFlTt2OXAaE25Y (26.07.2013)

However, by altering the ZOOM approach, the EQUAL-CLASS project could provide a more widely applicable method of using the template. The EQUAL-CLASS project focuses on three angles of qualifications: curricula etc., students, and graduates. Therefore, it may be possible to include results from the work on Remote Labs and from the alumni survey to provide more indicators and descriptors for the selected qualifications. This in turn would allow for the development of another approach to determining qualifications and could provide the foundation for the development of scenarios of validation procedures within the EQUAL-CLASS project.

6. Sources

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7. Annex

7.1. Template for description of selected qualifications in mechatronics, electronics / electrical engineering

EQUAL-CLASS
NQF_EQF_classificati

Equal class PROJECT

ENGINEERS QUALIFIED IN HIGHER NON-UNIVERSITY VET INSTITUTIONS – PROVIDING ARGUMENTS AND EVIDENCE FOR NQF/EQF CLASSIFICATION

Comparing qualifications in mechatronics & electrical engineering/electronics

European Qualifications Framework (EQF) levels 5-6
in Austria, Germany, Lithuania, Portugal and Switzerland

3 perspectives

LEARNING OUTCOMES
(THEORETICAL – DESCRIPTIVE)

Structured description and comparison of qualifications based on learning outcomes

- Using adapted methodology from the ‚ZOOM' project
- Comparing qualification profiles
- Comparing the assessment of knowledge, skills and competence

LEARNERS
(PRACTICAL – PERFORMANCE TESTING)

'Remote Laboratories'

- Online laboratories to remotely conduct real experiments
- Testing learners' PLC* knowledge, skills and competence
- Learners in the participating countries have to solve the same programming exercises online.

* PLC = Programmable Logic Controller

GRADUATES
(LABOUR MARKET)

Alumni survey

- Comparing graduates' occupations and positions in the labour market
- Web-based questionnaire in four different languages
  - Job level and status
  - Degree of responsibility
  - Career prospects
  - Type of tasks executed

+

How can learning outcomes acquired in the workplace be taken into account?

Desk research & interviews

- Validation and recognition of non-formal/informal learning
- Higher NQF/EQF level?

Can the results provide additional evidence for the classification of qualifications in the National/European Qualifications Framework?

Aims: Providing and testing a set of methodological tools

- for transnational comparison
- for the creation of transparency and
- for raising the understanding of a qualification

Further information: www.equal-class-eqf.eu
Duration of the project: 10/2012 – 09/2014
Partners from: Austria, Germany, Lithuania, The Netherlands, Norway, Portugal and Switzerland

Contact:
3s Unternehmensberatung GmbH (project coordinator) www.3s.co.at
Monika Auzinger auzinger@3s.co.at (+43) (1) 585 09 15-12
Viktor Fleischer fleischer@3s.co.at

Lifelong Learning Programme

GRUNDIGAKADEMIE

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This project has been funded with support from the European Commission. The content of this poster reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.