CWA Part III

Building the e-CF – a combination of
sound methodology and expert contribution

This document describes the methodological grounding for the development of the European e-Competence Framework (e-CF).

It has been constructed and benefits from the contributions of Clementina Marinoni and Irmhild Rogalla, methodological experts of the CEN nominated "e-CF in action" expert team, and lastly but not leastly from the constructive feedback received from the CEN ICT Skills workshop community.

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Executive Overview

The aim of this document is to describe the methodological grounding for the development of the European e-Competence Framework (e-CF). The e-CF expert team and European ICT stakeholders used this foundation, combined with their experience and industry knowledge, to inform decisions and choices.

The objective of the e-CF was to provide a common, shared, European tool to support organisations and training institutions in recruitment, assessment, competence needs analysis, learning programmes, career path design and development. It also aimed to support policy makers to define policies related to e-Skills development in education and in the work place. As European stakeholders were the target audience for the e-CF, the active involvement of experts and stakeholders from this community provided an essential ingredient in making the e-CF fit for purpose.

At the e-CF development project outset, four basic aspects of the forthcoming framework were considered. The e-CF expert group together with the European stakeholders made clear decisions on; 1) overall framework structure in four dimensions, 2) competence, knowledge, skill and attitude definitions, 3) ICT business processes and 4) the possible relationship between the e-CF and the EQF (the European Qualifications Framework), in particular between e-CF and EQF levels.

The decisions taken were as follows:

- **e-CF structure in four dimensions.** For the structure of the European e-Competence Framework, the experts analysed and evaluated other existing frameworks and agreed finally on a four dimensional approach. This structure is based on competence areas (dimension 1) and competences (dimension 2), instead of job profiles. Competence-based approaches are more flexible and foster local personalisation. Dimension 3 provides level assignments that are appropriate to each competence. The number of levels assigned to each competence varies and is dependent upon the nature and range of related activities. Dimension 4 provides short sample specifications of knowledge and skills but is not exhaustive.

- **Competence, skills, knowledge and attitude definitions**. In accordance with the overall approach regarding ICT stakeholder competence requirements, the definitions focussed on organisational competences instead of individual competences. However, individual competences can be identified within dimension 3 of the e-CF where competence proficiency levels are defined and are strongly related to autonomy and personal attitudes. Therefore it can be said that that Dimension 3 provides a bridge between organisational and individual competences. These definitions are in line with the EQF general definition of knowledge, skills and competence. However, it should be noted that EQF development is still in progress and continues progress towards the provision of improved competence descriptions.

- **Business Processes**. The combined team of e-CF experts and European stakeholders agreed to use, as a reference, a very general ICT process schema, compliant with most models provided by IT certification institutions (e.g. Exin, Cobit). The model includes process phases: Plan, Build, Run, Enable and Manage; where Enable and Manage are crosscutting phases. Within this document a broad description of the adopted process model is illustrated. Its purpose was to identify and define competences. It was used as a heuristic device and therefore should not be considered as a rigid definition of company business processes

- **Levels**. The e-CF experts and European stakeholder teams extrapolated from the EQF the following level indicators; "context complexity", "autonomy" and "behaviour" to help position competences. These characteristics reflect organisational perspectives on competence. The EQF uses further criteria such as "responsibility", but stakeholders elected to avoid this element as responsibility can be confused with the organisational accountability and erroneously link competence levels to organisation hierarchical levels. Consequently, the e-CF defines levels from the companies' viewpoint. However, as explained later in this document it also provides a link to the EQF and its associated learning levels.

The decisions taken in order to construct the e-CF were backed by theoretical and literature references. Within this document the relationship between best industry practice and current competence state of the art theory is explained. The overall methodology adopted was based on a step by step, bottom up approach focused upon stakeholders' experience and practical exploitation requirements. Methodological experts provided coherence with the definitions and the decisions taken at the outset of the project.

The methodological challenges were:

- Making stakeholders' views explicit

- Achieving agreement on possible choices and decisions

- Formalising decisons

- Structuring decisions and choices within the European e-Competence Framework

The process was based on consensus building, raising awareness among stakeholders and finding common views to establish a common language; a European currency for e-Competences. Literature and theoretical knowledge helped the team, when consensus was difficult; otherwise, the approach taken was to make the e-CF consistent and complementary to the original definitions and also to the EQF.

0   Introduction: The four dimensions of the e-CF

The European e-Competence Framework (e-CF) is structured from four dimensions. These dimensions reflect different levels of business and human resource planning and are specified as follows:

Dimension 1: five e-Competence areas derived from the ICT business processes PLAN – BUILD – RUN – ENABLE – MANAGE. This area is instrumental in HR assessment and the allocation of training programmes as well as the identification of e-competences. It helps HR managers to communicate with business managers and make joint decisions, in addition it is a first guide to organise and list e-competences.

Dimension 2: A set of reference e-Competences with a generic description for each competence. It is the core of the framework. 36 competences have been included in e-CF 2.0. These competences are not business sector-specific, i.e. they do not address specific applications such as banks, health, transport etc. They are general e-competences customisable and applicable to any industry or business sector. In dimension 2, e-competences refer to and represent organisation needs

Dimension 3: For each e-competence, suitable proficiency level specifications ranging between e-Competence levels e-1 and e-5 have been constructed. They relate to EQF levels 3 to 8. This dimension involves "behaviours" and levels of autonomy, a bridge from "organisational" to "individual" competences is created. Note that organisational competences are generic and broad whilst individual competences are specific and customised.

Dimension 4: Knowledge and skills embedded within e-Competences are listed. They are not intended to be exhaustive but are examples[1] of e-competence content. These examples can be useful, in defining specific and precise outcomes to be assessed within an organisation's competence assessment programmes. In addition, they provide inputs for training institutions[2] to help define learning outcomes and design training initiatives. Dimension 4 components refer to Dimension 2 but are not related to specific competence levels in dimension 3. However, Dimension 3 has been used to verify the applicability of knowledge and skills identified.

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[1] Choices related to skills and knowledge development provide a competitive key to address business success and vary widely in application across industry and education institutions. Hence knowledge and skills described in the e-CF are provided as examples and for contextual background. (see also "e-CF in action" Interim report 2009, chapter 5)

[2] Even though, Dimension 4 is constructed from an employer's perspective, Education and training institutions will be able to work with these short but precise e-competence components to revise or build curricula, syllabi, or learning programmes. However, it is not intended to restrict educational style or content solely to these descriptors, on the contrary, education providers are encouraged to produce materials complimentary to their culture. In consequence, the e-CF dimension 4 is deliberately confined to a set of key items acting as guidance but not limiting educational institutions to a rigid or narrow content. (see also "e-CF in action" Interim report 2009, chapter 5)

In Figure 1 an example of how the four e-CF dimensions can be applied to organisations is shown (see also CEN-CWA 15893-2:2008, p. 16)
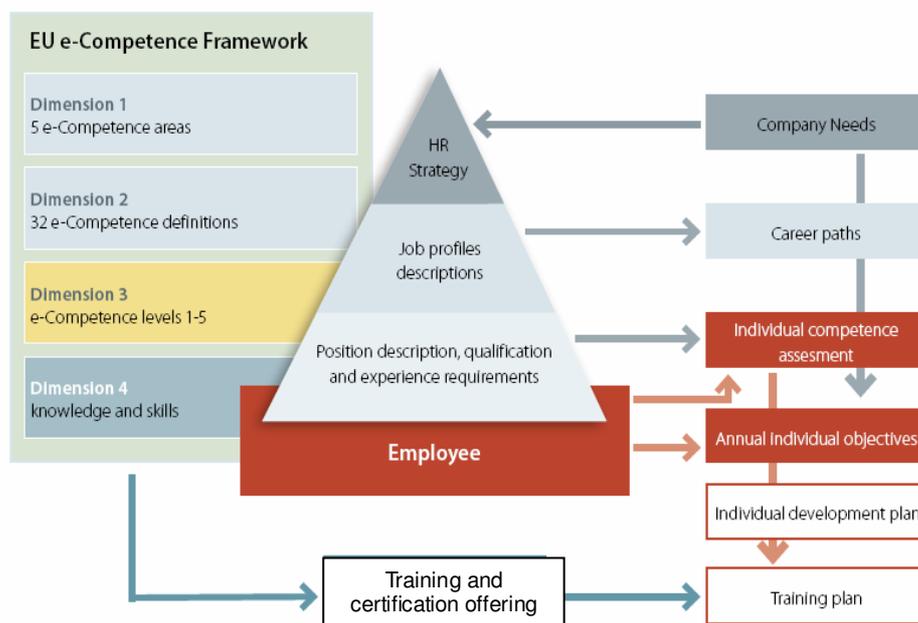

Figure 1 – examples of e-CF 4 Dimensions implementation into companies

- Organisations may use dimension 2 – the generic e-competence descriptions – to build job profiles.

- Dimension 2 competences can be combined with dimension 3 proficiency levels to describe career paths.

- Knowledge and skills from dimension 4 provide an opportunity to link competence and training programs.

As the schematic above demonstrates, the e-CF has a multidimensional structure. The e-CF is competence-based and is flexible in application. The alternative, job-profile approaches, are less flexible, making local adaptation difficult. However, combining competences from different competence areas and using them as building blocks can create flexible job-profiles. This enables the derived job-profiles to be easily updated by substituting or deleting competences without the need to restructure the entire profile.

1   Dimension 1: e-Competence areas

A common language for competences is valuable as a 'vocabulary', but it also needs to be structured to support collection and classification of content. A European language of competence must be translatable into other concepts. This includes job profiles and descriptions and structures for learning or certification or frameworks such as the EQF. The e-CF needs to meet multiple demands by providing user-friendly orientation and by being open and flexible.

1.1   Processes and e-Competence Areas

If competence can be linked to an individual's workplace capability, then a structure of competences can be derived from exploring the workplace. Work and business processes bring together individual and business demands, challenges, tasks, activities, results and outputs.

A business process is "a bundle of activities which needs one or more different inputs and which generates a value outcome for the customer" (Hammer, Champy 1994, p. 52, see also Hammer 2007; Gaitanides 2007).

A work process is a bundle of typical activities from a person or a team, mostly characterised by chronological sequence (see Binner 2004, Berben 2006, Buch, Frieling 2006).

Every work process is a part of a business process (in special cases work and business process are identical). So the relationship between business and work processes is always definite (see Gaitanides 2007).

Using processes as a base, provides the following:

- models for flexible orientation.

- a description of activities from different perspectives e.g. individual or teamwork processes, department or enterprise business processes. Additional processes can be used to describe relationships and dependencies between activities, e.g. sub-processes, simultaneous processes or dependencies from the results of previous processes.

- descriptions of different kinds of activities, e.g. software development, customer service or administration.

- comparisons across organisations (Enterprise or SME's) within the same business sector, because processes are patterns. Processes give the opportunity to describe activities and reduce reliance upon company specifics such as organisational charts.

Based on these characteristics, processes are ideally suited as a shared basic reference for collecting and classifying competences, mediated by categorising requirements.[3]

In the context of the e-CF development, it was also necessary to substantiate the process-model and the relationship between different kinds of processes, workplace requirements and ICT (or knowledge) areas. Based on the general business and work process model, as described above, different kinds of general and ICT specific process models were analysed and compared, searching for typical activities and processes. The models were based upon product life cycle management, systems and/or software life cycles, systems or software engineering/development, IT process improvement and quality, IT infrastructures and ICT working processes (see amongst others Stark 2004, Rogalla 2002, PLM, SPiCE, CMMI, ITIL). The comparison revealed:

1. In the majority of cases the structure of processes used in the models are similar. In consequence just two ICT specific models for developing and maintaining, CMMI and ITIL, were chosen for further investigation.

2. ICT Business process main components are Plan, Build, Run, Enable and Manage. Build and Run are core areas whilst Enable and Manage are crosscutting themes referring and relating to the former. Plan and Enable represent strategic areas, within companies that conceive, decide, design and set up products, services, actions and policies. Build and Run company daily business administration and improvement activities.
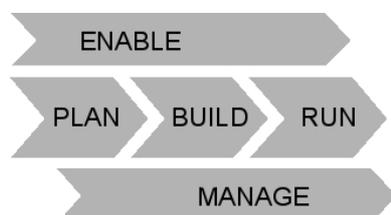

Figure 2 – The main components of the ICT business process

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[3] From a methodological, social psychological perspective, work and business processes can be named and used as boundary objects: "Boundary objects are objects which are both pliable enough to adapt to local needs and the constraints of multiple parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognisable, a means of translation." (Star, Griesemer 1999, p. 509; see also Star 1996 and Brown, Duguid 1998 for business processes as boundary objects). A boundary object renders co-operation between different people and organisations possible by allowing to maintain and to cross boundaries at the same time.

3. To ensure coherence with existing concepts, business processes were matched with ICT specific processes. All processes from CMMI (DEV/1.2 2006) and ITIL (v3 2007/2005) were categorised in this way for describing, fulfilling and defining ICT business processes in one step:

CMMI and ITIL-Processes (assigned to the business sub-processes)

	Run Controlling and exploiting operations Maintaining Supporting Training Documentation ...	Enable Security Quality Management Marketing and Selling Distributing/Supplying Procuring Acquiring (incl. outsourcing) Disposition ...
CMMI – DEV/1.2 (2006)	Determine Causes of Defects (Support: Causal Analysis and Resolution) Address Causes of Defects (Support: Causal Analysis and Resolution) Establish Baselines (Support: Configuration Management) Track and Control Changes (Support: Configuration Management) Align Measurement and Analysis Activities (Support: Measurement and Analysis) Provide Measurement Results (Support: Measurement and Analysis) Establish Organizational Process Assets (Process Management: Organizational Process Definition) Enable IPPD Management - IPPD Addition (Process Management: Organizational Process Definition) Establish an Organizational Training Capability (Process Management: Organizational Training) Provide Necessary Training (Process Management:	Establish Performance Baselines and Models (Process Management: Organizational Process Performance) Objectively Evaluate Processes and Work Products (Support: Process and Product Quality Assurance) Provide Objective Insight (Support: Process and Product Quality Assurance) Prepare for Validation (Engineering: Validation) Validate Product or Product Components (Engineering: Validation) Prepare for Verification (Engineering: Verification) Perform Peer Reviews (Engineering: Verification) Verify Selected Work Products (Engineering: Verification) Establish Supplier Agreements (Project Management: Supplier Agreement Management) Satisfy Supplier Agreements (Project Management: Supplier Agreement Management)
ITIL v3 / ISO 20000 (2007 / 2005)	Change Management (Service Transition) Transition Planning & Support (Service Transition) Asset & Configuration Management (Service Transition) Release and Deployment Management (Service Transition) Function: Service Desk (Service Transition) Function: Technical Management (Service Transition) Function: IT Operations Management (Service Transition) Function: Application Management (Service Transition) Event Management (Service Operation) Incident Management (Service Operation) Request Fulfilment (Service Operation) Problem Management (Service Operation) Access Management (Service Operation)	Knowledge Management (Service Transition) Service Validation & Testing (Service Transition) Evaluation (Service Transition)

Table 1 – CMMI and ITIL processes – assigned to the business sub-processes

4. Plan, Build, Run, Enable and Manage represent and contain all substantial workplace requirements from all ICT (or knowledge) areas. Thus competences can be described in the same way for a variety of areas such as software infrastructure, system integration, communication equipment and services.

All things considered, ICT Business processes proved to be a suitable vehicle for collecting and classifying requirements. In addition there was a need to describe the content of typical competences and proficiency levels and here the input from experts using their practical expertise and experience from a broad variety of environments was an invaluable ingredient.

ICT Business Processes were used essentially for developing the structure of the e-CF framework and using PLAN – BUILD – RUN – ENABLE – MANAGE in dimension 1, competences were categorised. This method was very useful for identifying, distinguishing and assigning the first competence examples.

However the concept of "business processes" is very generic. Different organisations have different business processes, different organisational structures and different business and working "cultures". Therefore in practice assigning a competence to a specific process, like PLAN or MANAGE is not an exact science and it plays a less important role in the completed e-CF framework than during its development.

1.2   ICT (or knowledge) areas

ICT (or knowledge) areas, see Table 2, provide a guide to contextualise e-competences with respect to specific content.

In addition they offered a dashboard to monitor and keep up with technology developments.

Knowledge Areas	Examples and definitions
Microelectronics; Components, Semiconductors	Chips, boards, microprocessors, integrated electronics, solid state memories, etc.
Computer HW	Computers and peripheral equipment, multimedia devices, etc.
Industrial Control Systems	Industrial large-scale systems, automation systems, production systems, etc.; embedded systems for automotive, aerospace systems (like aeroplanes), railway vehicles, etc; devices like medical devices, measuring, checking and control devices, radar devices, security devices, etc.; IT-systems and infrastructure for business (enterprise application and services)
Networks	Wide area networks, telecommunication infrastructure, traffic control systems, central building control systems, etc.
System Software	Operating systems, webservers, developing environments, emails, etc.
Applications Software	Software which automates a business process for a specific business sector
System Integration	Software packages (Applications Software and/ or System Software) integration to build more complex functions

Table 2 – ICT (or knowledge) areas

The e-CF experts discussed many approaches to identify and differentiate ICT Knowledge Areas. They came from different perspectives, academic, industry and education yet they jointly concluded to apply a pragmatic approach, consistent with the ISO approach to the OSI (Open Systems Interconnection) model.

The knowledge areas are only a background 'behind' the processes: As mentioned above the ICT Business processes were the vehicle for collecting and classifying competences. Additionally Plan, Build, Run, Enable and Manage represent and contain all substantial workplace requirements from all knowledge areas. So the knowledge areas only provide the applicable borders of e-competences.

2   Dimension 2: Competences

2.1   … in general

The concept of "competence" is ancient and goes back to the 18th century BC with the meaning of "authority" or "capability". The former refers to "possessing the responsibility, licence or right to decide, produce, serve, act, perform or claim", the latter refers to "having the knowledge, skills and experience to perform" (Mulder, 2007). Authority has been related to qualification and certification mechanisms, licences, official responsibilities, institutional leadership, whilst capability refers to one's own mastery, experience and know-how (even tacit and unconscious).

Up to the beginning of the nineteen nineties, "competence" was considered as an attribute of individuals. "*Each personal characteristic which (usually combined with others) allows the effective execution of a particular task in a given organisation* (McClelland, 1973) or "*an underlying characteristic of an individual, which is causally related to effective or superior performance in a job*" such as "*a motive, trait, skill, aspect of one's self image or social role, or a body of knowledge which he or she uses*" (Boyatzis, 1982)

With respect to these definitions, McClelland considers the context relevant, while Boyatzis opens up to possible de-contextualisation.

However, at the beginning of the nineteen nineties another competence perspective arose, i.e. the organisational point of view. With G. Hamel and C.K. Prahalad (1994) the "core competence" assumed a strategic meaning for the company; it represents the intangible asset for their competitive advantage. From that time on, the organisational perspective has also featured and is necessarily context-dependent.

The two approaches, from individual and from organisational points of view established two perspectives, individuals with their own competences, and business processes with their core competences.

Consequently, the identification of competences required by companies ideally would support either the organisation or the individual.

2.1   … in the e-CF

The experts and stakeholders involved in the e-CF development decided to use "operational" descriptions to make them comparable with EQF learning outcomes and to create a reasonable and logical bridge between the e-Competence Framework and the EQF qualifications framework.

The EQF defines learning outcomes as *'statements of what a learner knows, understands and is able to do on completion of a learning process and are defined in terms of knowledge, skills and competence'.* (EQF 2009).

The experts also chose the terms "competence" and "competences", in common with the EQF.[4] The terms "competence" and "competences" refer to their comprehensive meaning and to company requirements, reflecting their business process origins.

Consequently, the e-CF definition of "competence" formulated by the experts is as follows:

- Competence is "demonstrated ability to apply knowledge, skills and attitudes for achieving observable results".

This definition is consistent with the EQF which defines competence as "the proven ability to use knowledge, skills and personal, social and/ or methodological abilities, in work or study situations and in professional and personal development".

The e-CF definition of competence also encompasses social and personal abilities, as e-competences are *holistic units* expressing complex behaviours; they embed "attitudes" and degrees of individual autonomy; this becomes more evident when e-competences are described according to e-CF proficiency levels (see the next section for more details).

Regarding e-CF "skills", "knowledge" and "attitude" definitions, the experts and stakeholders decided that:

- Skill is the "ability to carry out managerial or technical tasks". Managerial and technical skills are components of competences and specify some core abilities that form a competence.

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[4] This topic is further explored in the document appendix 7.

- Knowledge represents the "set of know-what" (e.g. programming languages, design tools...) and can be described by operational descriptions.

- Attitude means in this context the "cognitive and relational capacity" (e.g. analysis capacity, synthesis capacity, flexibility, pragmatism...). If skills and knowledge are the components, attitudes are the glue, which keeps them together.

As learning outcomes in EQF and competences in EQF and e-CF mention "knowledge" and "skills", these two components provide a "loop-line" between EQF and e-CF. This establishes an added value opportunity to provide foundations for interoperability between learning outcomes and competence (see the CEN-CWA 16053:2009)

Identifying, clustering and describing ICT-competences required access to considerable expertise, experience and industry knowledge from the e-CF experts and the European ICT stakeholders. To focus this expertise, three maxims where adopted:

(1) **Criteria for including competences:** All decisions about new competence inclusion were made by the e-CF experts and also the European stakeholders. Criteria were based on the value and interest in the proposed new competence and its exploitation potential. For inclusion a competence needed to be widely used and practised (not just a fashionable trend) and be capable of integration into the e-CF framework in a consistent and coherent way. For example, a new competence about "Green-IT", was investigated for inclusion in the e-CF 2.0. Green-IT can be considered as a fashionable trend with unspecified substance. However "Sustainable development", the competence finally adopted as competence A.8, is more tangible and can be expressed in terms of environmental impact and energy consumption.

(2) **Relationships between tasks and competences:** Differentiation between competence and task is important to ensure competence framework integrity. Competence is described as an observable behaviour showing a "demonstrated ability to apply knowledge, skills and attitudes for achieving observable results". . A task is an action or a set of actions required carrying out a job activity. The defining difference between a task and a competence is the vital inclusion of personal and social components such as attitudes, which are vital integral ingredients of competence. Within version 2 of the e-CF particular attention was given to ensuring that competence descriptors incorporate the necessary personal and social elements. For instance the following are examples of terminology introduced to reflect these requirements; "make sound decisions", "systematically develop", "acts creatively", "provides leadership", etc… This attention was also focused on existing competences carried over from version 1 of the e-CF.

(3) **Granularity of competences:** Competences represent holistic, comprehensive and long lasting concepts and therefore must be of a low level of granularity. However, it is not easy to define or benchmark low, medium or high graduations of "granularity". In consequence, the

application of common sense and the fruits of discussions between stakeholders and experts pragmatically determined competence description granularity. In general, competence granularity should be lower than skill granularity, as skills are competence components; but higher than a role profile. However, some granularity compromises had to be made, for instance, making a competence higher than ideal to enable logical connections between some other job profiles and frameworks.

3 Dimension 3: Proficiency levels

3.1 …in general, according to the EQF

The concept of "proficiency levels" is an ongoing topic of interest.

Proficiency levels are related to job performance and differ from learning levels that are usually associated with training courses or qualifications.

"Proficiency" can be defined as a level of being capable or proficient in a specific knowledge, skill domain expertise or competence. Proficiency indicates a degree of mastery that allows an individual to function independently in the performance of a specific knowledge application, skill domain, expertise or competence.

However, proficiency levels have normally been linked to learning levels. Traditionally, learning level classifications have been provided to assess training outcomes (Bloom Kirkpatrick 1975), then related to job profiles (Mansfield, Mitchell 1996, Crawley 2001).

The European e-Competence Framework defines and describes e-competences and associated proficiency levels from the company viewpoint but also aligns with the EQF which uses learning levels[5].

Accordingly, the e-CF levels range from 1, the lowest to 5 the highest and they correspond to EQF levels 3-8. In Table 3 the correspondence between e-CF and EQF levels is shown.

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[5] From the latest debate about this issue among experts and stakeholders, it emerges that the EQF is required to recognise competences acquired in the workplace or at leisure. However as the EQF is learning outcomes-based and its purpose is to assess the results of a learning experience, it can also validate "learning at work". Accordingly, the EQF can be considered as a device that can be used by education systems but it can also become a mechanism to evaluate personal and professional development. It is able to link industry needs to educational requirements.

e-CF Level	*related to* EQF
e-5	8
e-4	7
e-3	6
e-2	4 and 5
e-1	3

Table 3 – Correspondence model between e-CF and EQF levels (CEN-CWA 15893-2:2008)

Both perspectives – the e-CF and the EQF – are interrelated as qualifications contribute to competence development. It is possible to build a bridge between the two frameworks by using comparable levels. As the e-CF describes competences as needed and applied at the workplace, the EQF levels 1 and 2 are not relevant for ICT sector competences. In addition the differentiation between EQF level 4 and 5 is too small to be reflected in the e-CF levels; for this reason they have been merged into e-Competence level e-2.

The next paragraphs describe the EQF levels approach and the methodology adopted by the e-CF to relate to the EQF in a transparent way.

3.2 Elucidation: EQF learning levels

The EQF provides 8 level descriptors of knowledge, skill, and competence learning outcomes. Each level is defined by a set of statements ('descriptors') indicating the *learning outcomes* relevant to the award of a qualification at that level in any system of qualifications[6].

From a detailed analysis of the EQF (and other Framework and profile systems) descriptors, (CEN-CWA 15893-2:2008) proficiency and learning outcome levels can be defined through three dimensions:

1. **Autonomy** ranging between "Responding to instructions" and "Making personal choices"

2. **Context complexity** ranging between "Structured – Predictable" situations and "Unpredictable – Unstructured" situations

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[6] From the latest debate on this issue among experts and stakeholders it also emerges that qualification levels (e.g. Bachelor, Master, PHD) are not established "by definitions". Each organisation has to demonstrate criteria used to level qualifications. Therefore it may be appropriate to consider learning outcomes as a first step. Levelling methods are still open, but most stakeholders agree on the use of parameters such as "context complexity", level of autonomy (and responsibility) and the "action verbs" used within learning outcome descriptions. These categories are embedded in the EQF levels.

3. **Behaviour** here representing an observable outcome and ranging between "the ability to apply" and "the ability to conceive".

Regarding behaviour, (CEN-CWA 16053:2009) it is intended as "observable behaviour", Europass shows a leading example on how it can be formalised by action verbs. Europass gives a list of action verbs to be used to fill in curricula and related documents to harmonise and standardise language. However, it states that these action verbs do not refer to learning/ proficiency levels. Nonetheless, the EQF uses different action verbs for different level descriptors. Several studies have tried to identify classes of action verbs and relate them to different grades and types of capabilities (ranging between operative, cognitive and relational capacities) and thus "structure performance domains" (Bloom 1956, Mansfield, Mitchell 1996).

In Table 2 a list of EQF distilled key phrases on the dimensions of Autonomy, Context and Behaviour is reported:

EQF levels	Autonomy	Context complexity	Action verbs
8	With autonomy, authority, commitment	Forefront context; Critical problems	Skills: Synthesize, Evaluate, Solve, Innovate, Extend and Redefine Knowledge Competence: Demonstrate, Develop new ideas and processes
7	Independently	Unpredictable and complex context / problems; Interface between fields	Knowledge: Original thinking, critical awareness Skills: Problem solving, Innovate, Develop, Integrate Competence: Manage, Transform, Reviewing Performance
6	Taking responsibility; On his/her own with responsibility	Unpredictable projects / processes; Specialized field	Knowledge: Critical understanding Skills: Innovate, Solve Competence: Manage, Decision Making
5	Under general supervision; On his/her own with confidence	Unpredictable activities / specific problems; Abstract problems	Knowledge: Awareness Skills: Develop Competence: Exercise, Review, Develop
4	Within the guidelines	Predictable; Within a field	Skills: Generate solutions Competence: Exercise, Supervise, Improve

EQF levels	Autonomy	Context complexity	Action verbs
3	Completion of assigned tasks	Predictable; Within a field	Skills: select, apply Competence: adapt

Table 4 – EQF distilled key phrases for Autonomy, Context and Behaviour (revision of the table in The CDIO to build a EQF-based engineering framework for Europe, April 2010, in press)

3.3 … in the e-CF

According to the EQF, competence levels depend on context complexity (e.g. routine, predictable, unpredictable, subject to changes contexts) and competence typologies (e.g. practical, cognitive, social, functional competences): the more dynamic and unpredictable the contexts are, the higher the competences must be. Competence levels also depend upon competence typology: e.g. "analysing" requires higher skills than "using tools".

Consequently, in order to define e-competence levels within the e-CF and assign consistent rules, context categories must be identified.

A set of characteristics which determine levels are applied to the e-CF; they reflect a typical company workplace perspective and are structured as follows.

Figure 3 – criteria for competence level graduation in the e-CF

Based upon previous studies (Deming 1989; Crawley 2001; Shewhart 1980; Mansfield, Mitchell 1996;

Bloom 1956) and the EQF, ICT competences can be grouped into competence categories[7] mainly concerned with:

- "Doing", "making": related to concrete actions and referred to either predictable or unpredictable contexts. E.g.: doing, using, applying, adapting, developing, deploying, maintaining, repairing, finding basic-simple solutions;

- "Co-ordinating", "operating": related to concrete actions and referred to either predictable or unpredictable contexts subject to changes. E.g.: scheduling, organising, integrating, carrying on, finding standard solutions;

- "Observing", "analysing", "listening to", "controlling", "driving": related to "conceptualising" and referred to either predictable or unpredictable contexts subject to changes. E.g.: surveying, designing, managing, supervising, monitoring, evaluating, improving, finding non standard solutions;

- "Choosing", "communicating", "enhancing": related to "conceptualising" and "by definition" referred to unpredictable contexts. E.g.: decision-making, team-building, personnel forming, performances reviewing;

- "Conceiving", "visioning", "foreseeing": related to "conceptualising" and "by definition" referred to unpredictable contexts. E.g.: planning, transforming, and innovating.

By following the EQF levels descriptions, it is possible to assign a level to any e-competence, according to the reference context typologies, action verbs, level of autonomy. Assigned levels are intended as "lower bounds".

The e-CF and EQF levels schema published in the EU e-Competence Framework accompanying user guidelines shows this approach.[8]

With regard to autonomy, the classification provided in the e-Competence Framework (CEN-CWA 15893-2:2008) following analysis of the EQF, was as follows:

"Responds to instructions; Works under general supervision; Interprets instructions, makes choices, works under broad direction; Has defined authority and responsibility for a significant area of work; Makes personal choices"

Concerning context complexity, the purpose was to consider learning/proficiency levels from the EQF and the e-CF to design curricula and syllabi to create interoperability options (see CEN-CWA 16053:2009). In particular, context examples of the most relevant, predictable-structured and

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[7] In this classification, "problem solving", is a cross cutting skill. It can be about finding solutions to routine problems, generating creative solutions to abstract problems, or extend as far as solving very complex and unpredictable problems.

[8] see Appendix 2: The EQF and e-CF level table

unpredictable-unstructured classes of professional contexts, in line with the e-Competence Framework were identified. These context examples are pioneering definitions, which warrant further research.

Some general remarks are useful to help understanding of e-CF level principles:

- each level inherits the content from lower levels;

- descriptions of e-competences associated to a level must include at least one of the action verbs characterizing the level;

- descriptions of e-comptences associated to a level should contain a limited number of action verbs associated with other levels

Following this guidance it was possible to assign consistent proficiency levels to each e-competence.

4 Dimension 4: Knowledge & Skills

4.1 … in general

The aim of conventional learning is traditionally to impart knowledge and skills. At school, for instance, children learn dates from history, at university students attend lectures to acquire knowledge and in vocational training, learners practice skills using physical tools. These activities are regularly recognised by the awarding of qualifications. Alternatively expressed, qualifications mainly recognise knowledge and skills acquisition. In contrast, competences articulate abilities, where an individual is able to do something within a specific context. Competences include knowledge and skills but they also include attitudes. Competences are holistic units that include complex behaviours. In conclusion knowledge and skills are necessary and useful but not sufficient to characterise competences. Knowledge and skills descriptions provide inputs for training institutions to help define learning outcomes and for design of training initiatives.

4.2 … in the e-CF

Dimension 4 (see CEN-CWA 15893-2:2008) articulates key skills and knowledge associated with each e-Competence as defined in dimensions 2 and 3. Dimension 4 therefore, contributes to the overall e-competence description by use of knowledge and skill examples. In Dimension 4 of the e-CF, each verb used within the skill description represents an objective and potentially verifiable action. Skills have been differentiated from "Tasks" even though boundaries are often unclear. Technically, a "task" is a specific activity to be conducted, while a "skill" is the ability to carry out a task. To illustrate this

challenge, "writing reports" may be a task, i.e. the activity of writing reports or it may be a skill, i.e. the ability to write reports. By convention, skills are expressed with the phrase "to be able to".

Definitions used in the e-CF:

- Knowledge represents the "set of know-what" (e.g. programming languages, design tools...) and can be described by operational descriptions.

- Skill is the "ability to carry out managerial or technical tasks". Managerial and technical skills are components of competences and specify some core abilities that form a competence.

- Attitude means the "cognitive and relational capacity" (e.g. analysis capacity, synthesis capacity, flexibility, pragmatism...) plus the motivation to do something. If skills and knowledge are the main components of competence, attitudes are the glue, which keeps them together.

In Dimension 4, "To know" just means "being familiar with", "being aware of", or "understanding", regardless of whether the piece of knowledge has been learnt, experienced, or acquainted with, etc.

The above definitions are also coherent with the EQF.

Regarding "attitude" it is comparable to the French "savoir être" or even to personal and social dimensions of competence. In fact, in the e-CF, attitudes are completely embedded in the e-Competence descriptions both in Dimension 2 and in Dimension 3. Attitudes are also set in the skills described in Dimension 4.

In this context, skills and knowledge can represent both e-competences and the learning outcomes to be reached through learning/ training paths. Consequently, skills and knowledge represent a bridge between organisation competences and education institution training or qualifications programmes.

5   Closing Comments

Three key outcomes of the e-CF methodological approach are highlighted below;

- The e-CF although pragmatic in application is designed and based upon current 'state of the art' business management thinking.

- e-competences in dimension 1 and 2 are presented from the organisational perspective as opposed to from an individual's perspective. Dimension 3 which defines e-competence levels related to the EQF, is a bridge between organisational and individual competences.

- The relativity between EQF learning levels and e-CF competence levels has been systematically developed to enable consistent interpretation of the EQF in the ICT workplace environment.

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PLM - Product lifecycle management:

http://en.wikipedia.org/wiki/Product_Lifecycle_Management [date-stamp: 10-01-07]

SPiCE (ISO 15504 - software process improvement and capability determination) is the standard for process improvement; based on/integrates ISO 12207.

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7 Appendix 1: Individual versus Organisational competence definitions

To identify an individuals competence, requires a "bottom up" approach based on methods such as interviews with identified "best performers", as exemplified in the BEI (Behavioural Event Interview) method. Whereas the organisational competence viewpoint requires a "top down" approach, based on either business or work process analysis methods.

Both approaches have advantages and disadvantages.

The bottom up approach provides an advantage in that competences are defined as characteristics of individuals and are causally related to actual performance; this provides objective and measurable descriptors. In addition, training initiatives can be identified and matched to individual needs. However identifying competences from "best performers", raises the question of whether they represent current and future requirements of the company. More importantly, using this method competences are defined by current employees and ignore potential competitive challenges and strategic requirements. It follows that although top down, organisational approaches are more difficult to link to individual competences and individual learning processes, they are more valuable in addressing an organisation's strategic objectives.

Given this scenario, how do we get the best of both approaches? How do we combine organisational requirements with individual behaviours and know-how? This debate is open and current.

In recent years discussion has also arisen about the differences between competence and competency. McClelland was arguably the first to distinguished between "competence" and "competency". With the former, he implicitly meant the general capability of persons to perform, with the latter he implicitly referred to competence components. I.e., "competency" may each time replace either a piece of knowledge or a skill or anything else (e.g. an attitude, a trait, etc.) contributing to achieve a defined result.

This is why competency and knowledge are sometimes used as synonyms; they are considered interchangeable especially in the United States and that adds to terminology confusion.

Winterton (2005) says that "'competence' generally refers to functional areas and 'competency' to behavioural areas but usage is inconsistent" as scientists tend to use those terms in disparate ways. A significant example is Elkin (1990) who "associates competences with micro-level job performance and competencies with higher management attributes […]. […] Burgoyne (1988) similarly distinguishes 'being competent' (meeting the job demands) from 'having competencies' (possessing the necessary attributes to perform competently)." In Winterton's opinion, "Woodruffe (1991) offers the clearest statement, contrasting areas of competence, defined as aspects of the job which an individual can perform, with competency, referring to a person's behaviour underpinning competent performance."

It is interesting to notice that according to the Learning Technology Standards tradition (IEEE, HR-XML), competency is "any form of knowledge, skill, attitude, ability, or learning objective that can be described in a context of learning, education or training."[9]

7.1   Some definitions from Europe

Winterton (2005) provides a very clear overview of the different national approaches to competence. The following is an overview of the main concepts and passages in his article.

If the US has been characterised by the behavioural approach to competences, in the UK the competence-based approach to qualifications and VET (Vocational Education and Training) was based on a functional, i.e. job-related, notion of competence. The U.K. National Vocational Qualifications Framework (NVQs) was based on occupational standards that emerged from the analysis of work activities from many work place contexts. One of the final and comprehensive definition of competence is "(Beaumont, 1996) [...] 'The ability to apply knowledge, understanding and skills in performing to the standards required in employment. This includes solving problems and meeting changing demand.'" (Winterton 2005).

In France, the growth of competence-based approaches was primarily linked to companies and their need to develop them. France therefore has been closer to organisational approaches. Moreover, competence representation, in France, is comprehensive, including "savoir", "savoir faire" and "savoir etre". "Savoir faire" can be related to Skills and functional competences (UK), while "savoir etre" to behavioural competences (US).

In Germany, in general, there was a reluctance to adopt modular approaches to competence based on fears about undermining craft occupations. Moreover, German notions of competence have been related to "learning" rather than "occupation", which were preferably translated with "Beruf". The main concept was "competence in action" (Handlungskompetenz) as an outcome of vocational learning paths, following the dual system approach (learning on the job connected with learning at school). The "competence in action" includes: a) "domain and methodological competence" (Fach- und Methodenkompetenz) that refers to context-related knowledge and skills, ; b) personal competence (Personalkompetenz), c) social competence (Sozialkompetenz), (Winterton 2005)

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[9] This definition is coherent with the US tradition where "competence" is the general term while "competency" refers to its elements (see McClelland)

7.2 The EQF approach

The EQF focuses on learning outcomes instead of learning process, it proffers that learning outcomes are of most importance and should be subject to evaluation and acknowledgement. More importantly, learning outcomes are required to be "observable" and "measurable" so that they can be assessed objectively. Such descriptions are called "operational" (Bridgman 1927/1960). These descriptions must be verifiable through observable behaviours or practical, experimental, empirical demonstrations, so that content can be gauged.

The EQF defines learning outcomes as *'statements of what a learner knows, understands and is able to do on completion of a learning process and are defined in terms of knowledge, skills and competence'.* And they are expressed by operational descriptions.

In particular, in the EQF (EQF 2009):

- Knowledge (K) "means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual"

- Skills (S) "means the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments)"

- Competence (C) "means the proven ability to use knowledge, skills and personal, social and/ or methodological abilities, in work or study situations and in professional and personal development. In the context of the European Qualifications Framework, competence is described in terms of responsibility and autonomy".

If "knowledge" and "skill" definitions are reasonably clear, the competence explanation is by contrast vague.

According to Winterton's (2005) competence model proposal, "Competence has four dimensions, two are "Occupational", i.e. work/study-related, two are "Personal", i.e. subject-related. The former dimensions are the so-called "cognitive competence" (that Winterton considers as "knowledge") and "functional competence" (considered by Winterton as "skills"), the latter include "meta competence[10]" and "social competence".

The general definition of competence provided by the EQF is consistent with Winterton's model but unfortunately the last sentence of that definition is confusing. Confusion increases in the last column of

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[10] It is incongruous that competence also includes meta-competence, as "meta", it should be beyond. It is either meta, and is not part of competence or it is a constituent of competence and therefore not "meta".

the EQF that refers to competence. Reading this column critically reveals more than the "simple" aspects of "autonomy" and "responsibility", it also includes "social competences". According to Winterton, if "competence[11]" is holistically composed of several elements it should not appear in a separate column of the framework but should represent and comprise of the combined contributing elements.

So the following EQF related questions arise:

- Why in the EQF is it stated that competence is described only in terms of "autonomy" and "responsibility"?

- Why does the column devoted to "competence" include more than "autonomy" and "responsibility"?

- Why is competence given the same "status" as "knowledge" and "skills", when it comprises of these elements and more?

This is an unclear aspect of the EQF. Nonetheless, the team developing and maintaining the framework is aware of this slight incoherence and the EQF being a dynamic object is still not completely defined (Bruxelles, 5-6 November 2009).

After all, Winterton states about competence "that it is impossible […] to arrive at a definition capable of accommodating and reconciling all the different ways that the term is used."

The same is true when referring to the use of "competence", "competency" and their plural. The EQF uses "competence" in the singular. According to Winterton's explanation, the singular mainly refers to the comprehensive and general concept of competence, usually more related to the organisational representation. But as already stated, the EQF is focussed on "competence" components within a learning context... Used in this way the IEEE call them "competency/ies". Importantly, by including aspects such as "social competences", the EQF gets closer to the personal dimension.

Regardless, it is an interesting quality of the EQF, that it tries to reconcile the strategic/organisational and individual approaches to competence application.

The personal dimension opens up to possible de-contextualisation of competence.

However, this is a very controversial perspective even when taking into account recent developments in defining competence. Moreover, sectoral developments of the EQF show that "proven abilities" change from context to context. As an example, being able to co-ordinate a football team is different from co-ordinating a team of cooks. Competence is a mixture of knowledge, skills and personal abilities that are always related to the specific content of the activity. Contexts are full of content that cannot be ignored or excluded. Finally, the EQF distributes knowledge, skills and competence

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[11]Called "competency" in many literal references.

descriptors across 8 levels. They can be "learning" levels if considered from the individual point of views, but also "proficiency" levels if seen from the organisational perspective[12].

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[12] EQF has opened up to non formal-informal learning environments and therefore to recognition of competences acquired on the job. In this interpretation , levels can also be read as "proficiency".

8   Appendix 2: The EQF and e-CF level table

EQF levels	EQF Levels descriptions	e-CF Levels	e-CF Levels descriptions	Typical Tasks	Complexity	Autonomy	Behaviour
8	Knowledge at the most advanced frontier, the most advanced and specialised skills and techniques to solve critical problems in research and/or innovation, demonstrating substantial authority, innovation, autonomy, scholarly or professional integrity.	e-5	**Principal** Overall accountability and responsibility; recognised inside and outside the organisation for innovative solutions and for shaping the future using outstanding leading edge thinking and knowledge.	IS strategy or programme management	Unpredictable - unstructured	Demonstrates substantial leadership and independence context which are novel requiring the solving of issues that involve many interacting factors.	Conceiving, transforming, innovating, finding creative solutions by application of a wide range of technical and / or management principles
7	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking, critical awareness of knowledge issues in a field and at the interface between different fields, specialised problem-solving skills in research and/or innovation to develop new knowledge and procedures and to integrate knowledge from different fields, managing and transforming work or study contexts that are complex, unpredictable and require new strategic approaches, taking responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams.	e-4	**Lead Professional / Senior Manager** Extensive scope of responsibilities deploying specialised integration capability in complex environments; full responsibility for strategic development of staff working in unfamiliar and unpredictable situations.	IS strategy/holistic solutions		Demonstrates leadership and innovation in unfamiliar, complex and unpredictable environments. Addresses issues involving many interacting factors.	
6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles, advanced skills, demonstrating mastery and innovation in solving complex and unpredictable problems in a specialised field of work or study, management of complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts, for continuing personal and group professional development.	e-3	**Senior Professional / Manager** Respected for innovative methods and use of initiative in specific technical or business areas; providing leadership and taking responsibility for team performances and development in unpredictable environments.	Consulting	Structured - unpredictable	Works independently to resolve interactive problems and addresses complex issues. Has a positive effect on team performance.	Planning, making decisions, supervising, building teams, forming people, reviewing performances, finding creative solutions by application of specific technical or business knowledge/skills
5	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge, expertise in a comprehensive range of cognitive and practical skills in developing creative solutions to abstract problems, management and supervision in contexts where there is unpredictable change, reviewing and developing performance of self and others.	e-2	**Professional** Operates with capability and independence in specified boundaries and may supervise others in this environment; conceptual and abstract model building using creative thinking; uses theoretical knowledge and practical skills to solve complex problems within a predictable and sometimes unpredictable context.	Concepts/Basic principles		Works under general guidance in an environment where unpredictable change occurs. Independently resolves interactive issues which arise from project activities.	Designing, managing, surveying, monitoring, evaluating, improving, finding non standard solutions Scheduling, organising, integrating, finding standard solutions, interacting, communicating, working in team
4	Factual and theoretical knowledge in broad contexts within a field of work or study, expertise in a range of cognitive and practical skills in generating solutions to specific problems in a field of work or study, self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change, supervising the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities.				Structured - predictable		
3	Knowledge of facts, principles, processes and general concepts, in a field of work or study, a range of cognitive and practical skills in accomplishing tasks. Problem solving with basic methods, tools, materials and information, responsibility for completion of tasks in work or study, adapting own behaviour to circumstances in solving problems.	e-1	**Associate** Able to apply knowledge and skills to solve straight forward problems; responsible for own actions; operating in a stable environment.	Support/Service		Demonstrates limited independence where contexts are generally stable with few variable factors.	Applying, adapting, developing, deploying, maintaining, repairing, finding basic-simple solutions

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