MACE: Deliverable 5.5 - Integration of Competence Metadata

MACE Metadata for Architectural Contents in Europe

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MACE

Integration of Competence Metadata in MACE

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e*Content*plus

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[1] OJ L 79, 24.3.2005, p. 1.

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Overview

MACE Infrastructure

Introduction

The MACE infrastructure is a highly distributed system, currently being developed by several consortium partners at different locations and in principle open to everyone. The infrastructure is and will be developed with the interests of the following groups in mind:

- the content providers, connecting their repository to MACE in order to make their contents more accessible,
- the content consumers, in different situations who use MACE to get better results for their searches, and
- the technical developers, creating new widgets and solutions on top of the existing infrastructure.

For all these groups, good programming interfaces to MACE are an important concern. By defining clear, stable and easy-to-use application programming interfaces, MACE enables:

- the content providers, to connect to MACE by implementing a Harvesting and a DirectLink interface,
- the content consumers, to search for and acquire contents on the MACE portal, also by using provided compact, embeddable interface components (so–called ”widgets”) at other sites,
- the technical developers, to create new solutions and widgets by supporting them with defined and documented web services, that allow access to the metadata collected.

Service oriented architecture

A web services based service oriented architecture (SOA) was chosen to achieve the goals stated above. The services can be used from everywhere and everyone via the internet – if technical and legal requirements are met. Several advantages result from this architecture; mainly flexibility and maintainability. Every service provider is able to create specific application programming interfaces in the beginning, and is able to create their software independently based on the MACE infrastructure. Hence, new implementations and improvements extend the MACE infrastructure without interfering with existing solutions.

Additionally, the SOA approach enables simpler testing and evaluation procedures because every service guarantees its accurate functionality and the mobility of code, as services can easily be shifted and redeployed on different servers.

To ensure full interoperability, all services will be based on open standards. We use OAI-PMH for metadata harvesting and SOAP for remote web service connectivity. The search service is enabled through the Simple Query Interface (SQI) for MACE to be able to join learning objects repositories (LOR) federations like Globe3 and Ariadne4. SQI allows for the federation of queries and the collection of the query results. SQI can be combined with any query language, and is, for example, employed in the GLOBE consortium to federate queries over the global network of learning repositories (Ternier et al., 2005).

Layers: databases and services

The MACE infrastructure consists of multiple layers with different duties. Services connect the presentation layer (user interfaces) with data sources (metadata databases, repositories).

The metadata services process queries and return results, and provide means for gathering and manipulating metadata. The business logic services provide common functionality such as user management and event logging, while others are more complex and can even aggregate and combine data and functionality. Besides metadata and content retrieval, these services allow users to annotate contents with own metadata, track activities and generate metadata from user actions. These layers are:

- Content repositories: Various repositories with architectural learning objects,
- Metadata databases: MACE and external databases with metadata for contents of different kinds,
- Metadata services: Services to interact with for querying and enriching metadata contents (see also deliverable JD4),
- Business logic: Basic and combined services, and
- Interfaces: Widgets, tools, applications and other front-ends the user sees and interacts with.

As the various domain tasks are modularised, they can be reused and extended by combining and integrating multiple existing services. The modularisation and precisely separated responsibilities result in less complexity in each single layer.

Usage of Competence Metadata

The EU-funded MACE project, in which EAAE is participating, is aiming at federating architectural repositories or contents in Europe.[2] In doing so, MACE also will enrich the data describing the contents, the so called learning objects with four types of metadata related to content, context, usage and competences. This MACE progress report is describing how MACE will structure the competence metadata and how this fits into today's developments in education in Europe.

In the wake of the Bologna process, learning contents are no longer expressed in contents taught to the students, but in competences acquired by the student while studying a content object. Competences and Bologna go hand in hand. The introduction of the Bachelor-Master structure is the means to a better comparability of diplomas and that of course requires a system of quality assurance and quality assessment. As a first step in quality assessment programmes are no longer characterised by learning contents, but by acquired competences. Thus all educational subjects have to be expressed in the competences they are aiming at. There is a subtle distinction between learning outcomes e.g. knowing 300 Chinese characters and competences e.g. the ability to speak Chinese.

Which competences characterize which diploma and at what level, is still subject of debate and investigation. We probably cannot solve this in the MACE program due to its complex nature. Instead, MACE is proposing a system for tagging competences, knowing what is going on and in full awareness of the needs of architecture. It is not the task, neither the ambition of MACE to come up with the final set of competences and to produce a competence metadata tagging tool open to allow the specification of a competence.

In 2005 EU has produced a Qualifications Directive 2005/36/EC ruling the mutual recognition of 600 professional qualifications within the 27 EU member states.[3] This

2 http://mace-project.eu

3 'Directive 2005/36/EC of the European Parliament and of the Council on the Recognition of Professional Qualifications' of 7 Sept 2005 - section 8, Architect / Article 46, pp.47,48

Directive includes for architecture a list of 11 points or competences, inherited without any change from the Architect's Directive 85/384 EEC, and agreed upon by the member states. These competences are needed for a diploma to be called a diploma of architecture:

(a) ability to create architectural designs that satisfy both aesthetic and technical requirements;

(b) adequate knowledge of the history and theories of architecture and the related arts, technologies and human sciences;

(c) knowledge of the fine arts as an influence on the quality of architectural design;

(d) adequate knowledge of urban design, planning and the skills involved in the planning process;

(e) understanding of the relationship between people and buildings, and between buildings and their environment, and of the need to relate buildings and the spaces between them to human needs and scale;

(f) understanding of the profession of architecture and the role of the architect in society, in particular in preparing briefs and that take account of social factors;

(g) understanding of the methods of investigation and preparation of the brief for a design project;

(h) understanding of the structural design, constructional and engineering problems associated with building design;

(i) adequate knowledge of physical problems and technologies and of the function of buildings so as to provide them with internal conditions of comfort and protection against the climate;

(j) the necessary design skills to meet building users' requirements win the constraints imposed by cost factors and building regulations;

(k) adequate knowledge of the industries, organisations, regulations and procedures involved in translating design concepts into buildings and integrating plans into overall planning. "

The domain specific competences for architecture are well known and we will not repeat these here. Similarly MACE uses another set of competences for construction engineers.

In education we have to distinguish between competences at bachelor level and at master level, eventually at doctoral level. We also have to distinguish between university and other educational levels: the university claiming a strong scientific approach. Competences related to a specific type of education (university, high school, college...) or level of education (bachelor, master...) are called generic competences transcending individual disciplines. Not all competences required for practicing a profession (for example those needed for full access

to the profession of a self-employed architect) are acquired in an academic setting, and need apprenticeship.

The three Technical Universities Netherlands propose the following list of generic competences for technical universities: [4]

1. is competent is one or more scientific disciplines
2. is competent in doing research
3. is competent in designing
4. has a scientific approach
5. possesses basic intellectual skills
6. is competent in co-operating and communicating
7. takes account of the temporal and social context.

The domain specific competences - the 11 competences as well as the engineering competences - can further be refined along several levels of achievement.

Levels or degrees of achievement within these competences are further specified along the so called Dublin descriptors, the taxonomy of Bloom, ABET criteria, CDIO (Concept Design Implementation and Organisation – MIT), TUNING, etc. The ACQA i system proposed by TU/e considers the following four dimensions of competences: capability to analyse, to synthesize, capability to abstract (induction), to concretize (deduction).

The Dublin descriptors for the bachelor and master have been created by an international group of experts in order to structure qualifications; they pertain to knowledge, attitudes and skills. They are listed in ascending level of achievement:

1. knowledge and understanding-insight,
2. applying knowledge and insight,
3. judgment,
4. communication,
5. learning to learn

These allow making distinctions between the bachelor and the master level. In fact there is no general agreement on these competences. These are definitely cognitive competences and it is

4 Meijers, A.W.M., & van Overveld, C.W.A.M., e.a. Criteria for Academic Bachelor's and Master's Curricula TU/e, Eindhoven, 2005 (ISBN: 90-386-2217-1) Order from:M.E.H.A.Rossou@tue.nl Info at:http://www.tue.nl/academiceducation

obvious that they may cover scientific teaching and learning environments, but not education programmes with an artistic dimension.

Taxonomies, like the one proposed by Bloom come already closer to the needs of such an education, although also Bloom does not list creative behaviour, entrepreneurship as a capacity, initiative, critical thinking …

Reality is that today several initiatives try to establish operational competence taxonomies and ENHSA is taking care of that within the TUNING project initiated by EUA.[5]

In order to better understand the Dublin descriptors, let us recall that Bloom distinguishes three categories of mental capabilities. [6, 7]

- cognitive capacities: knowing, understanding, applying, analysis, evaluation, synthesis
- psychomotoric capacities: reading, writing, speech, drafting,..
- dynamic-affective capacities: working in group, leadership, …

The Dublin descriptors only consider the cognitive capacities and architectural education definitely needs more. Meijers proposes to further subdivide the level of achievement of these capacities: [8]

- expert
- proficient
- competent
- advanced beginner.
- novice

All this should allow the full characterization of the competences in education.

However, since there is no consensus on all this and since the work on competences in architecture just has started/is ongoing, since the professional organisations of architects only

5 http://ec.europa.eu/education/policies/educ/tuning/tuning_en.html

6 B. S. Bloom (Ed.) Taxonomy of Educational Objectives: The Classification of Educational Goals; pp. 201-207, Susan Fauer Company, Inc. 1956.

7 Lorin W. Anderson, David R. Krathwohl, Peter W. Airasian, Kathleen A. Cruikshank, Richard E. Mayer, Paul R. Pintrich, James Raths and Merlin C. Wittrock (Eds.) A Taxonomy for Learning, Teaching, and Assessing — A Revision of Bloom's Taxonomy of Educational Objectives; Addison Wesley Longman, Inc. 2001

8 Meijers, A., ACQA: Academische Competenties en Quality Assurance, Leuven, June27, 2007

start now to think competences; MACE proposes the following open system for specifying competences:

- generic competences (related to academic education at Bachelor and Master level)
- the existing list of domain specific 11 competences as listed in the Qualifications Directive 2005 or similar ones for related disciplines
- other competences following Bloom (or another taxonomy)

As a consequence MACE will use 3 tags at the maximum per competence as follows:

1. Tag with keywords (short descriptors of a, b, c) the generic and domain specific competences
2. Specify the level of education or type of education involved: Ba / Ma / Dr / profession / LLL (life long learning)
3. Specify the level of achievement by means of the Dublin descriptors, plus Bloom or whatever other pedagogical classification of mental capabilities.

Example

Competence: understand the behaviour of structures. At the university:

- at Bachelor level: knowing that structures exist, which types to use when, understand structural systems conceptually
- at Master level: knowing how to design a structure (= proficient)
- at Doctoral level: being able to compute a structure (= expert)

The MACE tagging will be: "*Understand structures (domain specific)*", "*University Master level*", "*Applying or conceive creatively*"

Integration of Competence Metadata

Competences and learning processes are often implicitly used in training and education only in the recent years; competences are more and more explicitly used to structure curricula, plan personal development plans and other educational activities. To metatag learning objects with information about competencies is a difficult task and requires expert knowledge not only about the domain but often also about the underlying pedagogy. In a first step for the infrastructure for MACE in WP5 the consortium created a flexible set of applications to collect and catalogue competence descriptions, manage and maintain those descriptions and offer an open API to integrate services based on such a competence catalogue into different end user tagging applications.

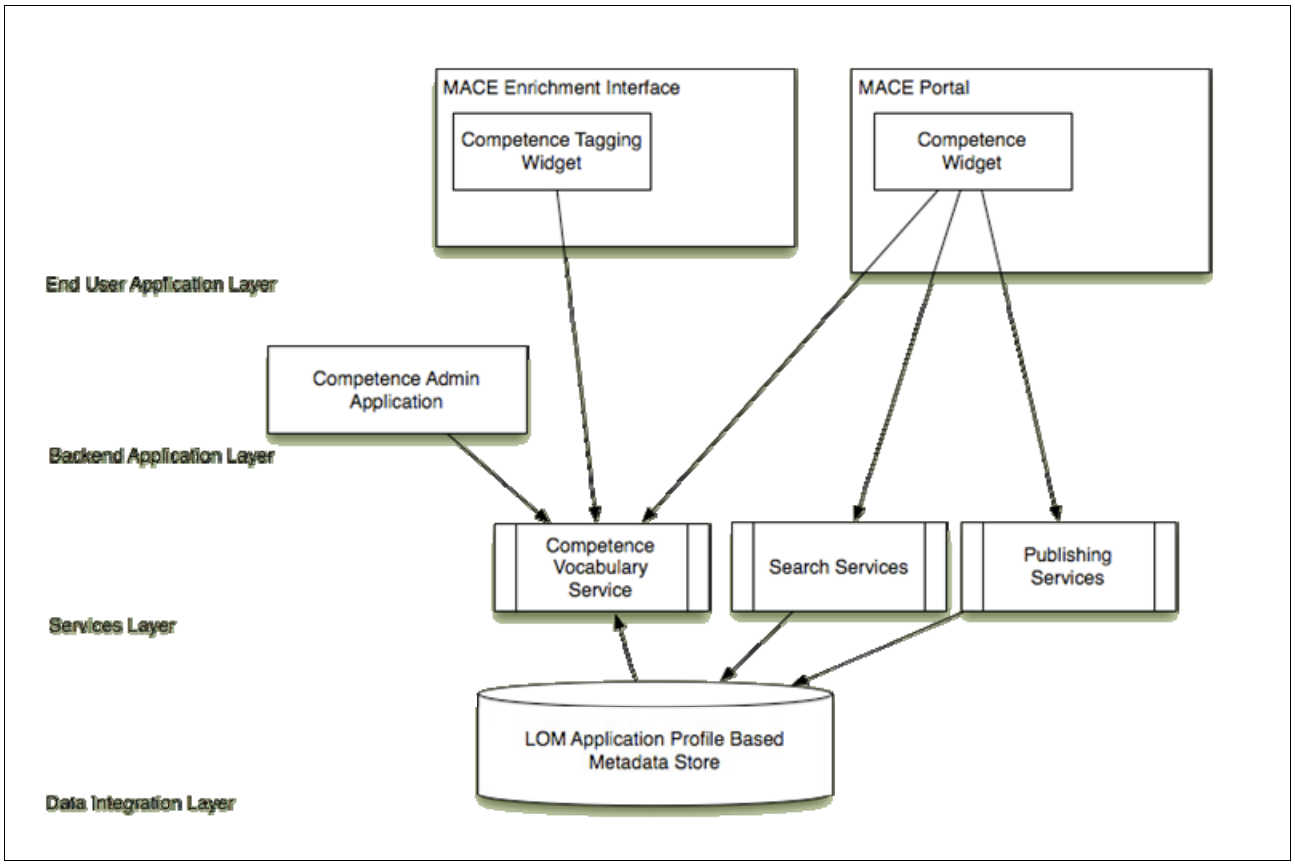

Figure 1: MACE Competence Metadata Service Layers

MACE Application Profile

Specification for Competence Metadata

The MACE application profile (AP) includes a large number of possible classifications. Thus it also stores the metadata related to competencies for each learning object (LO) and real world object (RWO) in the classification section of the AP. The classification of the AP section is described below.

Classification

	Field Name	Explanation	Value Space (where not specified, follow LOM v1.0)	Required
9	**classification**	This category describes where this learning object falls within a particular classification system.		Nice to have
9.1	purpose	The purpose and description of classifying this learning object.	LOM v1.0 loose: competency Architecture Competency Classification Engineering Competency Classification	
9.2	taxon path	A taxonomic path in a specific classification system. Taxon path is used as grouping element for source and taxon entries.		
9.2.1	source	The name of the classification system including its URL. Usually, this should at least be the URL of the MACE Classification Server or the Competence Server.		req. if 9.2
9.2.2	taxon	A particular term in a classification. This element is used to as grouping element for id and entry elements.		req. if 9.2
9.2.2.1	id	The identifier of the taxon, usually the ID of the taxon, e.g. in the MACE Classification Server or the competence server.		req. if 9.2

	Field Name	Explanation	Value Space (where not specified, follow LOM v1.0)	Required
9.2.2.2	entry	The textual label of the taxon which is called the "topic" in the MACE Classification Server or the Competence Server..		req. if 9.2
9.2.2.3	mineqf	Used to specify the mineqf for the referenced competence.	Integer value	
9.2.2.4	maxeqf	Used to specify the maxeqf for the referenced competence.	Integer value	
9.3	description	The description of the classification including the sources for the values.		

Each LO or RWO can have any number of competencies associated to it. For each competency of a LO or RWO, the minimum and maximum value associated with the competency, defined according to the European Qualification Framework, are included in the proposal. The possible classifications (taxon path and values) for Architecture Competencies and Engineering Competencies are listed below.

Architecture Competency Classification

9.1	purpose	Architecture Competency Classification
9.2	taxon path	
9.2.1	source	DIRECTIVE 2005/36/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL ON THE RECOGNITION OF PROFESSIONAL QUALIFICATIONS, Section 8 - Architect, Article 46 - page 95 http://www.riba.org/fileLibrary/pdf/Qual_Dir_en_7_09_05.pdf and Council Directive 85/384/EEC Chapter II - article 3 http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&numdoc=31985L0384&model=guichett&lg=en
9.2.2	taxon	
9.2.2.1	id	competencies
9.2.2.2	entry	Ability to create architectural designs that satisfy both aesthetic requirements

			Ability to create architectural designs that satisfy the technical requirements Adequate knowledge of the history of architecture Adequate knowledge of the theories of architecture Adequate knowledge of the arts Adequate knowledge of the technologies Adequate knowledge of the human sciences Knowledge of the fine arts in quality of architectural design Adequate knowledge of urban design (in the planning process) Adequate knowledge of planning Adequate knowledge of skills involved in the planning process Understanding ofthe relationship between people and building Understanding of the relationship between buildings and their environment Understanding of the relationship between to relate building and spaces between human needs and scale Understanding of the profession of architect in preparing briefs Understanding the role of the architect in the society in preparing briefs Understanding methods of investigation of the brief for design project Understanding methods preparation of the brief for design project Understanding of the structural design problems associated with building design Understanding constructional problems associated with building design Understanding engineering problems associated with building design Adequate knowledge of physical problems with internal conditions of comfort and protection against the climate Adequate knowledge of technologies for the internal condition of comfort and protection against the climate Adequate knowledge of the function of building for the internal condition of comfort and protection against the climate Necessary design skills to meet buildings users' requirement

			Necessary design skills to meet buildings users' requirement constraints imposed by cost factory Necessary design skills to meet buildings users' requirement building regulations imposed by cost factory Adequate knowledge of the industries involved in translating design concepts into buildings Adequate knowledge of the organizations involved in translating design concepts Adequate knowledge ofregulations involved in translating design concepts Adequate knowledge of the procedures involved in translating design concepts (into buildings and integrating plans into overall planning)
9.3	description	The competency map where competencies with weights for this LO are stored.	

Engineering Competency Classification

9.1	purpose	Engineering Competency Classification	
9.2	taxon path		
9.2.1	source	Based on the results of the EUCEET II - European Civil Engineering Education and Training II project, that is part of the Tuning project (2005 - 2006)(http://tuning.unideusto.org/tuningeu/) Based on professional Spanish Legislation and new Spanish high studies catalogs (according to Bologna's declaration)	
9.2.2	taxon		
9.2.2.1	id	competencies	
9.2.2.2	entry		Ability to apply knowledge of mathematics and other basic subjects
			Ability to apply knowledge of mathematics and other basic subjects relevant to construction engineering Ability to design a system or a component to meet desired needs Ability to identify, formulate and solve common construction engineering problems Ability to design and calculate products, processes, systems and buildings related to all the constructive fields Ability to design and conduct experiments, as well as analyze and interpret data

			Ability to identify research needs and necessary resource Ability to use the techniques, skills and modern engineering tools, including IT, necessary for engineering practice Ability to apply knowledge in a specialized area related to construction engineering Ability to function in multi-disciplinary teams Ability to manage, plan and supervise multidisciplinary teams Ability to do research, development and innovation of products, processes and constructive methods Ability to elaborate, lead and manage projects related to all the constructive fields Ability to develop and apply the strategic planning to productive, quality and environmental management systems Ability to manage technically and economically projects, processes, systems and buildings related to all the constructive fields Ability to apply the knowledge to solve problematic situations in new wide and multidisciplinary environments Ability to formulate high complexity judgments with incomplete or limited information that includes the social and ethic responsibilities Ability to communicate effectively knowledge to specialized and non-specialized public in a clear and unambiguous way Understanding of the interaction between technical and environmental issues and ability to design and construct environmentally friendly construction engineering works Understanding of the elements of project and construction management of common construction engineering works Understanding of professional and ethical responsibility of construction engineers Understanding of the impact of solutions for construction engineering works in a global and societal context Understanding of the role of the leader and leadership principles and attitudes Recognition of the need for, and the ability to engage in, life-long learning and have the learning abilities that make possible the continuous learning in an autonomous way Capacity to adapt to new situations and generating new solutions
9.3	description	The competency map where competencies with weights for this LO are stored.	

MACE Competence Services

The core of the MACE Competence Services is the provided competence catalogue. The catalogue will contain competence domains and their related competencies as well as resources, experts, evidences and proficiency scales related to this competencies.

The competence catalogue itself is an object oriented application written in Java and is able to output the contained data in several output formats such as XML and JSON. The application cannot be used stand-alone. It can only be used via the designated web services (competence web service and competence administration service) described later in this section. The web services are deployed on a Glassfish v2 application server and can be accessed using its SOAP API.

The web services enable front end applications, especially the competence widget and the competence administration application to query and manipulate data contained in the competence catalogue.

Competence Web Service

The competence web service is is an abstraction layer to the competence catalogue to provide access to it. The service accesses the contained data via a web service, which provides the following methods:

METHOD	DESCRIPTION
getVersion	Get the current version of this webservice
getStatus	Get the current status of this webservice
getDomains	Get a list of all the available domains
getCompetenceList	Get the full list of competences from the database
getCompetenceListFromDomain	Get a basic list of competences from the databasefor a specific domain
getBasicCompetence	Get a basic competence from the system
getBasicCompetenceList	Get a basic list of competences from the database
queryCompetences	Query competences in the database
getCompetence	Get one competence from the database and all the related experts, evidences and resources
importCompetence	Import a competence

getResourcesFromCompetenceId	Get all the resources for a certain competence
getEvidencesFromCompetenceId	Get all the evidences for a certain competence
getExpertsFromCompetenceId	Get all the experts for a certain competence
getProficiencyScale	Get a proficiency scale from the database
getCompetencesForResource	Get all competences for a certain resource
getCompetencesForExpert	Get all competences for a certain expert
getCompetencesForEvidence	Get all competences for a certain evidence

The service can be accessed using a SOAP API. The location of the WSDL and the full API specification can be found at http://maceservices.ou.nl.

Competence Administration Web Service

The competence administration web service is is another abstraction layer to the competence catalogue to administer it. The service accesses the contained data via a web service, which provides the following methods:

METHOD	DESCRIPTION
getVersion	Get the current version of this webservice
getStatus	Get the current status of this webservice
listDomains	Get a list of all the domains
createDomain	Add a domain
readDomain	Read a domain
updateDomain	Update a domain
deleteDomain	Delete a domain
listCompetences	Get a list of competences from the database
createCompetence	Create a new competence
readCompetence	Get one competence from the database and all the related experts, evidences and resources
updateCompetence	Update the competence in the database
deleteCompetence	Delete a competence from the database
listResources	Get a list of all the resources
createResource	Add a resource
readResource	Read a resource

updateResource	Update a resource
deleteResource	Delete a resource
listExperts	Get a list of all the experts
createExpert	Add an expert
readExpert	Read an expert
updateExpert	Update an expert
deleteExpert	
addExpertToCompetence	Add an expert to a competence
addResourceToCompetence	Add a resource to a competence
addEvidenceToCompetence	Add an evidence to a competence

The service can be accessed using a SOAP API. The location of the WSDL and the full API specification can be found at http://maceservices.ou.nl.

MACE Competence Applications

The MACE Competence Applications are applications and widgets that users can interact with. The usage spectrum goes from information display, dynamic updating, information editing to administration. The applications and widgets make use of the competence web service and the competence administration web service mentioned in the MACE Competence Services section.

Competence Widget

Using the final MACE portal, it will be possible for the user to fully browse the included content repositories and search for learning objects (LO) as well as for real world objects (RWO). For every LO or RWO a detail page will be provided. This detail page will among other things contain all implemented widgets to easily visualize, enrich and edit the application profile of every LO or RWO.

One of these widgets will be the competence widget to visualise the competence metadata and aggregations of its values. Additionally, it will allow the editing of the competence metadata. The widget is currently developed by the OUNL and is implemented with Adobe Flex[9] Builder using the open source Flex SDK.

9 http://en.wikipedia.org/wiki/Adobe_Flex

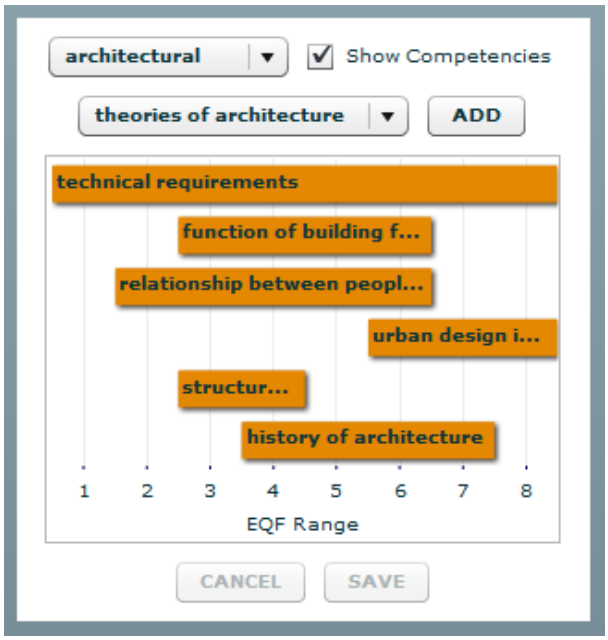

Figure 2: Competence Widget (1)

The widget is connected to the competence web service and the MACE content enrichment service. The competence web service is described in the MACE Competence Services section and will be provided by the OUNL. It uses the services in the following way:

Embedded in the MACE widget container, the competence widget gets notified of a newly selected learning object, by subscribing to respective LOMLoaded event, which contains both the LO id as well as the already assigned competence data. Alternatively, in a different context, it could also query the MACE search service via SQI to retrieve LOM metadata on its own.

The data will be visualized using a bar chart as a basic metaphor showing the aggregated competencies with their EQF-range. The MACE content enrichment service enables the user to add and remove competencies to and from the classification section of the application profile and edit the EQF-ranges of the already aggregated competencies via the widget. The competence web service will in this context be used to provide the widget with information out of the competence catalogue, especially available competence domains and their related competencies. The service ensures data integrity with the competence catalogue.

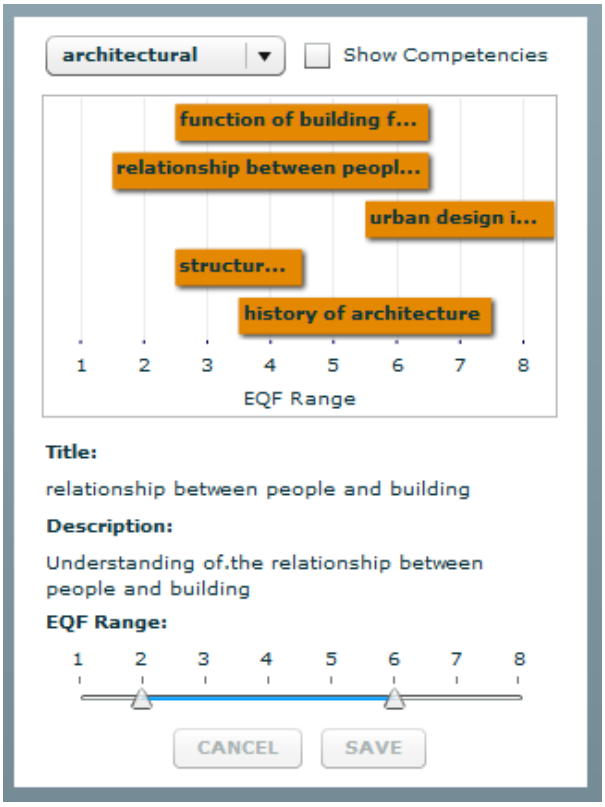

Figure 3: Competence Widget (2)

The user will as a result see all aggregated competencies for any LO or RWO filterable by domain characterised by their EQF-range and will be able to add and remove aggregated competencies as well as edit their EQF-range.

Due to the fact that the implementation of the competence widget is not finished and the final version of the MACE portal is not launched yet, right now the “classification widget” (FHP) is used for tagging competence metadata. Users can use the “Quick add” field to pick known values by a smart autocompletion textfield. If the value to assign is not clear yet, users can use the hierarchical classification visualization to browse for applicable terms.

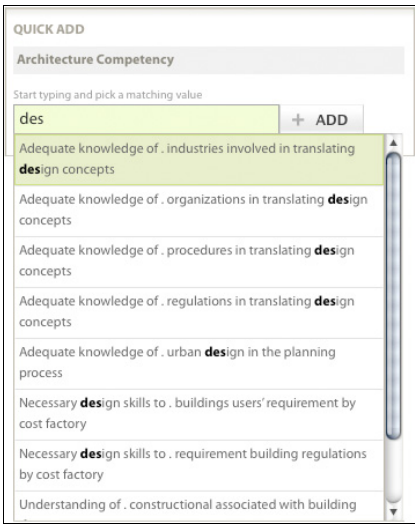

Figure 4: Quick Add Field

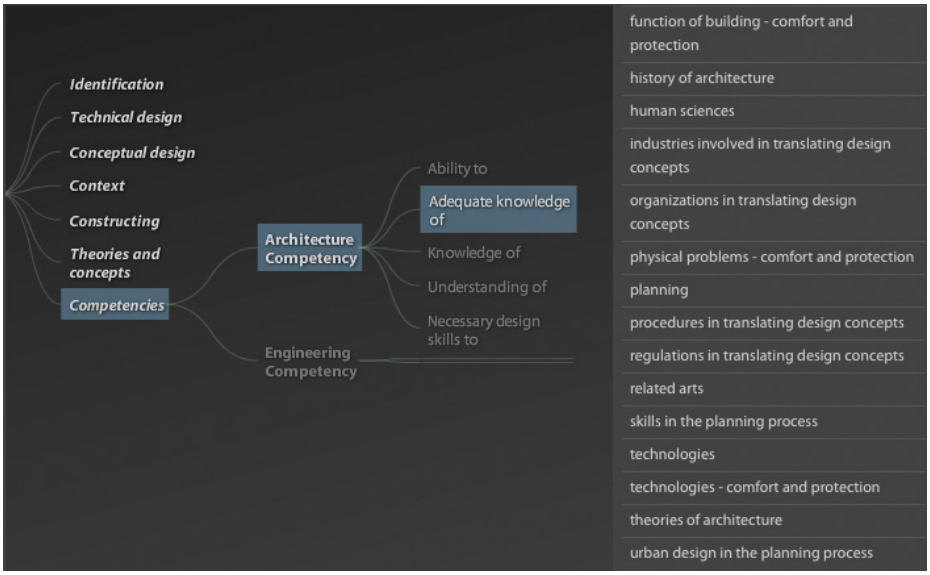

Figure 5: Classification Browser

Right now the already existing classification widget created by FHP is used for tagging competence metadata. Similar to tagging classifications out of the application profile the user chooses a competence title out of the application profile and adds this to the selected LO or RWO. A logged in user can then save the edited classification and thus submit it to the classification section of the application profile via the classification service.

Competence Administration Application

Fundamental for working with the competence widget is the already mentioned competence catalogue. To maintain this catalogue the Competence Administration Application will be used.

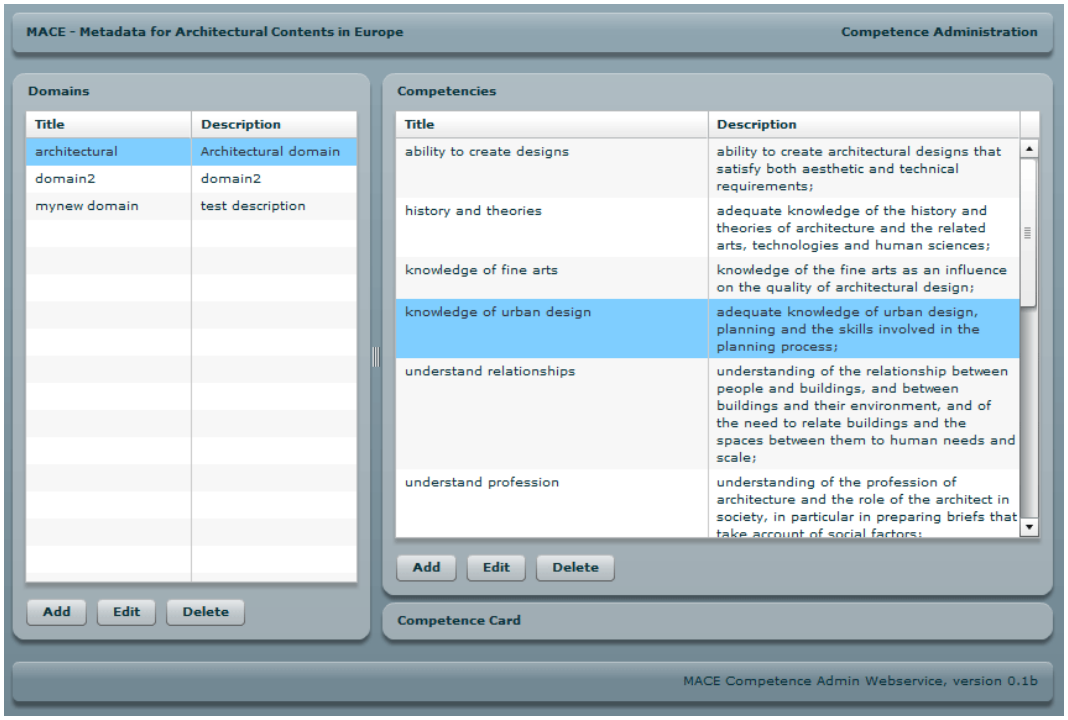

Figure 6: MACE Competence Administration Application (1)

The application will be implemented with Adobe Flex Builder using the open source Flex SDK. It is connected to the competence web service and the competence administration service. Both services are described in the MACE Competence Services section and will be provided by the OUNL.

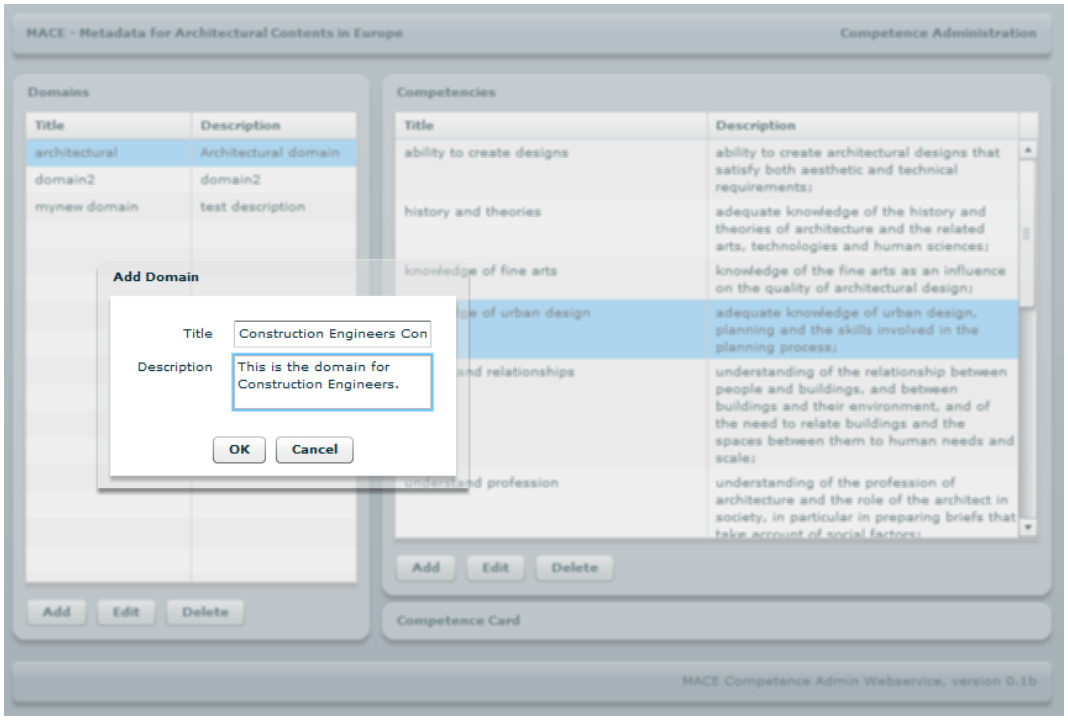

Figure 7: MACE Competence Administration Application (2)

The application will be implemented as a rich internet application (RIA), meaning that it enables the user to easily browse and manipulate the competence catalogue. It therefore visualizes the existing competence domains and their related competencies at a first glance. The logged in user can then add, remove and edit as well domains as competencies to the competence catalogue. At a second glance the application includes the competence card application described in the next section.

Competence Card Application

As a separable part of the competence administration application the competence card applicationvisualizes the related resources, experts, evidences and proficiency scales for a competence. The logged in user can then add, remove and edit as well competencies as resources, experts, evidences and proficiency scales to the competence catalogue. The application will organise the information in a card stack metaphor and will enable the user to explore the space of resources, experts, evidences and proficiency scales from a competence perspective.

The application will be implemented as an independent component of the competence administration application with Adobe Flex Builder using the open source Flex SDK. It makes use of the following services: competence web service and the competence administration service. Both services are described in the MACE Competence Services section and will be provided by the OUNL.

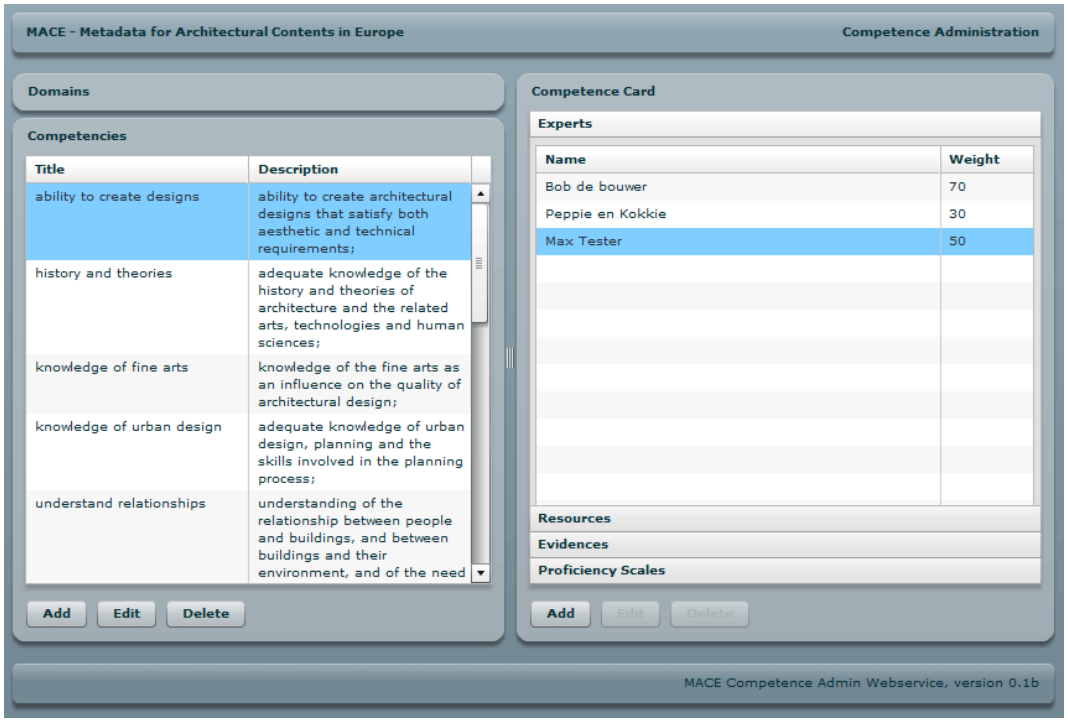

Figure 8: Competence Card Application

Considering the usage of the application different metaphors and user interfaces for the competence management are tested. This is currently under development also in the TENCompetence Personal Competence Manager.

MACE Competence Taxonomies and Competence Definitions

Architecture Competency Classification

ID	TITLE	DESCRIPTION
1	Ability to.create aesthetic requirements	Ability to create architectural designs that satisfy aesthetic requirements
2	Ability to.satisfy technical requirements	Ability to create architectural designs that satisfy the technical requirements
3	Adequate knowledge of.history of architecture	Adequate knowledge of the history of architecture
4	Adequate knowledge of.theories of architecture	Adequate knowledge of the theories of architecture
5	Adequate knowledge of.architecture related arts	Adequate knowledge of architecture related arts
6	Adequate knowledge of.architecture related technologies	Adequate knowledge of architecture related technologies
7	Adequate knowledge of.architecture related human sciences	Adequate knowledge of architecture related human sciences
8	Knowledge of.fine arts as influence on architectural design	Knowledge of the fine arts as an influence on the quality of architectural design
9	Adequate knowledge of.urban design	Adequate knowledge of urban design
10	Adequate knowledge of.planning	Adequate knowledge of planning
11	Adequate knowledge of.skills involved in the planning process	Adequate knowledge of the skills involved in the urban design and planning process
12	Understanding of.relationship between people and building	Understanding of the relationship between people and building
13	Understanding of.building relation with the context	Understanding of the relationship between buildings and their environment
14	Understanding of.relationship between building spaces and human needs	Understanding of the need to relate buildings and the spaces between them to human needs and scale

15	Understanding of.profession of architecture	Understanding of the profession of architecture and the role of the architect in society, in particular in preparing briefs and that take account of social factors;
16	Understanding of.methods of brief investigation/preparation	Understanding of the methods of investigation and preparation of the brief for design project
17	Understanding of.structural problems in architectural design	Understanding of structural design problems associated with building design
18	Understanding of.constructional problems in architectural design	Understanding of constructional problems associated with building design
19	Understanding of.engineering problems in architectural design	Understanding of engineering problems associated with building design
20	Adeguate knowledge of.physical problems for internal conditions of comfort	Adequate knowledge of physical problems with internal conditions of comfort and protection against the climate
21	Adeguate knowledge of.technologies for internal conditions of comfort	Adequate knowledge of technologies for the internal condition of comfort and protection against the climate
22	Adeguate knowledge of.function of building for internal conditions and comfort	Adequate knowledge of the function of building for the internal condition of comfort and protection against the climate
23	Necessary design skills to.meet users' requirement and cost factors	Necessary design skills to meet buildings users' requirement constraints imposed by cost factors
24	Necessary design skills to.meet users' requirements and regulations	Necessary design skills to meet buildings users' requirement and building regulations
25	Adequate knowledge of.industries involved in translating design concepts	Adequate knowledge of the industries involved in translating design concepts (into buildings and integrating plans into overall planning)
26	Adequate knowledge of.organizations involved in translating design concepts	Adequate knowledge of the organizations involved in translating design concepts (into buildings and integrating plans into overall planning)
27	Adequate knowledge of.regulations involved in translating design concepts	Adequate knowledge of regulations involved in translating design concepts (into buildings and integrating plans into overall planning)
28	Adequate knowledge of.procedures involved in translating design concepts	Adequate knowledge of the procedures involved in translating design concepts (into buildings and integrating plans into overall planning)

Engineering Competency Classification

The definition of the Engineering Competences has been based on Dublin Descriptors elaborated by the Join Quality Initiative network and on the results of the EUCEET II - European Civil Engineering Education and Training II project that is part of the Tuning Project (2005 - 2006).

After, they have been checked (as example) against on the professional Spanish Legislation and new Spanish high studies catalogues (according to Bologna's declaration) to assure that the work done under MACE initiative drives to a real approach scenario in terms of engineering competences classification.

Dublin Descriptors – The Joint Quality Initiative is an informal network for quality assurance and accreditation of bachelor and master programmes in Europe. It stems from the Bologna declaration (1999) in which European ministers of Education committed themselves, among other things, to adopt a higher education system essentially based on two main cycles.

And from the follow-up Prague communique (2001) which called upon various actors

- to co-operate in quality assurance
- to design scenarios for mutual acceptance of evaluation and accreditation/certification mechanisms
- to collaborate in establishing a common framework of reference
- to disseminate best practice

The initiative originated from a meeting in Maastricht of countries with comparable quality assurance systems, which introduced or considered introducing accreditation of bachelor and master programmes. Actions are aimed at transparency in bachelor and master programmes. For additional information refer to http://www.jointquality.org/

In September 2003 the Berlin Communiqué 2003, Ministers refer to an overarching framework of qualifications for the European Higher Education Area:

> *"Ministers encourage the member States to elaborate a framework of comparable and compatible qualifications for their higher education systems, which should seek to describe qualifications in terms of workload, level, learning outcomes, competences and*

profile. They also undertake to elaborate an overarching framework of qualifications for the European Higher Education Area."

One of the results of these works is a set of descriptors that is known as Dublin Descriptors. These descriptors are the basis for subsequent work that establishes the sequence of three Dublin Descriptors that relate to completion of the first, second and third Bologna cycles (Bachelor's, Master's and Doctoral awards) and indicates the progression steps between the cycles.

Tuning project - Tuning Educational Structures in Europe is a university driven project which aims to offer a concrete approach to implement the Bologna Process at the level of higher education institutions and subject areas. The Tuning approach consists of a methodology to re-design, develop, implement and evaluate study programmes for each of the Bologna cycles. Furthermore, Tuning serves as a platform for developing reference points, expressed in terms of learning outcomes and competences, at subject area level. Tuning competences can be distinguished in subject specific (subject-area related or specific to a field of study) and generic ones (common to any degree course). Subject specific competences are classified in nine subject areas e.g. Business Administration, Chemistry, Education Sciences, European Studies, History, Earth Sciences, mathematics, Nursing and Physics and also in different thematic networks focussing on a field of study (Tuning Project, 2007).

Civil Engineering is one of the Socrates Thematic Networks which is called EUCEET II - European Civil Engineering Education and Training II. There are several universities, professional associations, educational associations and research centers, related to the field of the Civil Engineer, from different European countries involved in the project. Its main objective is to enhance the co-operation between universities, faculties and departments of civil engineering in Europe, with the involvement of academic and professional associations, in order to contribute to the development of civil engineering education and to increase its quality and effectiveness (Prof. Josef Macháček, Member of EUCEET SC, 1999). After the analysis of several questionnaires and evaluations 18 specific competences for Civil Engineering Education where defined.

Therefore, from the analysis of the Dublin Descriptors, the 18 competences coming from Tunning Project and refined by comparison to the ones historically defined in professional Spanish Legislation (Spanish legislation is highly restrictive in terms of professional

competences) and the new Spanish high studies catalogues (according to Bologna's declaration), the MACE Engineering Competency classification has been fixed.

ID	TITLE	DESCRIPTION
1	Ability to.apply knowledge of basic construction engineering subjects	Ability to.apply knowledge of mathematics and other basic subjects relevant to construction engineering
2	Ability to.design a system or component	Ability to.design a system or a component to meet desired needs
3	Ability to.solve construction engineering problems	Ability to.identify, formulate and solve common construction engineering problems
4	Ability to.design and calculate	Ability to.design and calculate products, processes, systems and buildings related to all the constructive fields
5	Ability to.design experiments and interpret data	Ability to.design and conduct experiments, as well as analyze and interpret data
6	Ability to.identify needs and resource	Ability to.identify research needs and necessary resource
7	Ability to.use modern engineering tools	Ability to.use the techniques, skills and modern engineering tools, including IT, necessary for engineering practice
8	Ability to.apply knowledge in a specialized construction engineering area	Ability to.apply knowledge in a specialized area related to construction engineering
9	Ability to.function in multi-disciplinary teams	Ability to.function in multi-disciplinary teams
10	Ability to.manage teams	Ability to.manage, plan and supervise multidisciplinary teams
11	Ability to.develop and innovate	Ability to.do research, development and innovation of products, processes and constructive methods
12	Ability to.elaborate and manage construction projects	Ability to.elaborate, lead and manage projects related to all the constructive fields
13	Ability to.planning management systems	Ability to.develop and apply the strategic planning to productive, quality and environmental management systems
14	Ability to.manage technically and economically	Ability to.manage technically and economically projects, processes, systems and buildings related to all the constructive fields
15	Ability to.solve problematic	Ability to.apply the knowledge to solve problematic

	situations	situations in new wide and multidisciplinary environments
16	Ability to.formulate judgments with limited information	Ability to.formulate high complexity judgments with incomplete or limited information that includes the social and ethic responsibilities
17	Ability to.communicate knowledge	Ability to.communicate effectively knowledge to specialized and non-specialized public in a clear and unambiguous way
18	Understanding of.the interaction between technical and environmental issues	Understanding of.the interaction between technical and environmental issues and ability to design and construct environmentally friendly construction engineering works
19	Understanding of.project and construction management elements	Understanding of.the elements of project and construction management of common construction engineering works
20	Understanding of.professional and ethical responsibility	Understanding of.professional and ethical responsibility of construction engineers
21	Understanding of.the impact of solutions for construction engineering works	Understanding of.the impact of solutions for construction engineering works in a global and societal context
22	Understanding of.the leadership	Understanding of.the role of the leader and leadership principles and attitudes
23	Ability to.continuous learning in an autonomous way	Ability to recognize .the need for, and the ability to engage in, life-long learning and have the learning abilities that make possible the continuous learning in an autonomous way
24	Ability to.adapt to new situations	Ability to.adapt to new situations and generating new solutions

[i] Meijers, A., ACQA – Academische Competenties en Quality Assurance – TU/e, Leuven (B), June 27, 2006.