COMPETENCE BASED FRAMEWORK

FOR CURRICULUM DEVELOPMENT

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Abstract

This document is intended to provide an overview of the competence based framework for university curriculum development. The document serves as a handbook designed for the academic staff training workshop held in ULSIT, Sofia, Bulgaria on 24-28 February 2014 within the framework of the European funded PICTET Tempus project.

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The main objective of the handbook is the development and advancement of procedures and tools for designing and implementing competence based curriculum matching competences in higher education and economy.

The document serves as a reference handbook designed for the academic staff training workshop held in ULSIT, Sofia, Bulgaria on 24-28 February 2014 within the framework of the European funded PICTET Tempus project. Also, it supports the designed technology-enhanced training course "Competence based framework for curriculum development" integrated in Moodle.

This document provides an overview of the competence based framework for curriculum development. Sections 1-2 present the context and common used competence definitions. Section 3 provides information about three competence dictionaries as effective tools for building competence profiles and catalogs where each competence is presented by definition and behaviour indicators.

Section 4 presents the proposed systematic methodology for competence based curriculum development. The methodology consists of six phases: (1) Conceptualisation; (2) Planning; (3) Data collection; (4) Data analysis & Create catalog of competences; (5) Develop competence based curriculum and (6) Develop applications & Pilot test.

Section 5 is referencing frameworks and data collection tools as the European Qualifications Framework for lifelong learning and various Web based information systems for competence modeling and assessment: the European e-Competence Framework, Bulgarian Competence Assessment Information System MyCompetence, USA O*NET and ESCO.

Sections 6 to 9 explain in brief procedures for creating catalog of competences and developing competence based curriculum, as well as the proposed sample template for describing innovative learning scenarios and behaviour assessment for competence based earning.

The last section is focused on the Computer Science Curricula 2013, Curriculum Guidelines for Undergraduate Degree Programs in Computer Science, December 20, 2013, The Joint Task Force on Computing Curricula, Association for Computing Machinery (ACM), IEEE Computer Society.

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1. Context

„With labour markets increasingly relying on higher skill levels and transversal competences, higher education should equip students with the advanced knowledge, skills and competences they need through their professional lives."
(The Bologna Process 2020)

In a recent communication, the European Commission called upon the Council to endorse an updated framework for future European cooperation in Education and Training, with four strategic objectives for the years leading up to 2020: Make lifelong learning and learner mobility a reality; Improve the quality and efficiency of provision and outcomes; Promote equity and active citizenship; Enhance innovation and creativity, including entrepreneurship, at all levels of Education and Training. Educational and training systems must generate new skills, respond to the nature of new jobs which are expected to be created, as well as improve the adaptability and employability of adults already in the labour force. Universities should offer innovative curricula, teaching methods and training/retraining programs which include broader employment-related skills, along with the more discipline-specific skills, to enhance the employability of graduates and to offer broad support to the workforce more generally.

Many researches about educational system point the attention on competence-based education is at a crossroads. Traditional content driven and time based models of education are criticised as being too theoretical and for failing to meet the demands of practice, while newer ones based on skills and competency are called into question for being atomistic, controlling and confined to the predictable. The need of changes is extremely urgent in other to meet the rapidly changes in the economy, industry and social environment. The Competence Based Education (CBE) is a systematic yet flexible approach. It focuses on defining in measurable terms what students are to learn and then evaluating how well they can perform designated tasks after instruction. Expected behaviours or tasks, conditions for their performance, and acceptable standards are shared with students. Some of the main focal points of CBE are: its purpose is to promote learners to achieve a presetting ability, each individual learner's behaviour in the learning process is of concern; its evaluation is to emphasize criterion-referenced. The main reason for CBE popularity is the expected reduction of the gap between the labour market and the school system.

Even before the beginning of the 21st century academic education had been moving away from the traditional knowledge-based approach towards more competence-based teaching. Recently this process has become more of a preoccupation. With the introduction of the Bologna process, many EU universities have experienced increased interest from the professional and commercial sectors for their interests to be included into the academic environment. As a result, universities have developed initiatives to adapt their academic teaching to the requirements of industry, in order to ensure that their graduates are the most employable, and to increase their competitiveness in the international education market. As a result a new form of curriculum development has arisen, which has focused on finding the relationship between university education and the competences needed by the graduates in their later careers, by defining exactly which competencies need to be included in the respective courses. This new competence-based approach is nowadays one of the most discussed topics in curriculum development.

It is generally believed that competence-based education is an answer to societal changes. In particular the professional environment has become more complex, dynamic and knowledge intensive and it requires employees who are well educated, versatile and able to maintain their personal knowledge and skills. The concept of competence is a mean to think about these changes and requirements.

The interoperability of competence (learning outcome) definitions constitutes a major challenge for competence based learning designs and its implementations. Currently, higher education institutions have not yet adopted standards for competence definitions, resulting in inefficiencies for, both competence based learning design and competence based discovery, access and re-use of units of learning.

Learning outcomes, the current hot topic within the educational institutions across Europe, are analysed, designed, implemented and evaluated all over Europe. Learning outcomes are the backbone of the current, modern educational initiatives; such as the European Qualifications Framework (EQF) on the one and the Qualifications Framework for the European Higher Education Area (QF-EHEA) on the other hand. Traditional models and methods of expressing learning success and qualification levels are replaced by systems based on learning outcomes and qualification descriptors. These systems ultimately provide the necessary transparency to facilitate the comparison of knowledge, skills and abilities between education institutions in different European countries.

The main objective of the handbook is the development and advancement of procedures and tools for designing and implementing competence based curriculum matching competences in higher education and economy.
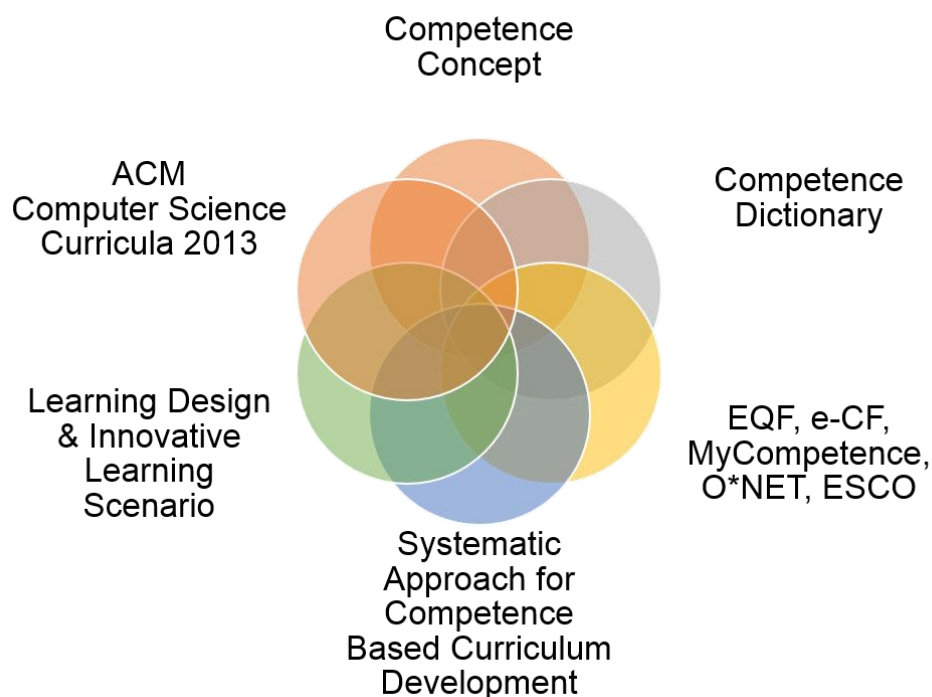
2. The Concept of Competence

The concept of competence can bridge the world of education, training, knowledge management, and informal learning. There are a lot of examples of competence definitions. The concept of 'competence' or 'competency' is the subject of ongoing discussion.

The researchers in the field of competence have given various definitions for what competencies are: permanent distinctive traits and characteristics which determine performance; distinctive characteristics which differentiate the successful performer from the rest; an ability to reach goals; inner personality traits that allow a person to cope better with a given task, role or situation; knowledge, skills, abilities and other characteristics demonstrated at work, etc. However, there is no set definition for the term competence. Debates on the difference between competence and competency are still ongoing.

In the context of the European Qualification Framework, "competence 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".

According to IEEE Reusable Competency Definition (RCD), a "competency is defined as any form of knowledge, skill, attitude, ability or educational objective that can be described in a context of learning, education or training".

According to TENCompetence definition "competence is the estimated ability of an actor to deal with some classes of critical events, problems or tasks that can occur in a certain situation and ecological niche".

Tuning Educational Structures in Europe defines competences as a dynamic combination of knowledge, understanding, skills and abilities. Competences are obtained or developed during the process of learning by the student. A distinction can be made between generic competences (i.e. transferable competences across study areas) and subject-specific competences (i.e. competences specific to a subject area).

The International Board of Standards for Training and Performance Instruction (IBSTPI) defines a competency as "a knowledge, skill, or attitude that enables one to effectively perform the activities of a given occupation or function to the standards expected in employment".

The methodology used by Bulgarian Industrial Association in the *Competence Assessment Information System MyCompetence(http://en.mycompetence.bg)* considers competence to be a set of knowledge, skills, attitudes and behaviours used to achieve results (performance levels) in a certain professional role or in a particular organisation. Acquiring a certain level of competence can be seen as an expression of the individual's ability to combine and integrate in their behaviour (independently, own know-how) the different elements of skills and knowledge, of professional and personal qualities, of past experience. In other words, competencies are an expression of the individual's ability to perform well at work. To illustrate what has been written thus far, an "in-depth model" of competencies can be used.

There are a number of competence classifications which organise them according to different criteria. Competences can be divided into "soft" (related to behaviour and influence) and "hard" (related to technical abilities); "core competencies" (relevant for the company's success), "functional competencies" (common characteristics for groups of jobs with similar functions), "specific competences" (job specific ones); "distinctive competencies" (which

differentiate the successful performer from the poor one), "threshold competencies" (basic characteristics for the person performing a particular job) and "transformational competencies" (developing ones).

With the adoption of the Lisbon Strategy (2010), a decision was taken to modernize and enhance education quality which would in turn lead to mastering **seven universal key competencies:**
- **Communication in the mother tongue;**
- **Communication in foreign languages;**
- **Competence in mathematics, science and technology;**
- **Digital competence;**
- **Ability to learn;**
- **Intercultural and social competencies, and civic competence;**
- **Initiativeness and entrepreneurship.**

Four universal personal and professional competencies as learning outcomes have been established with the adoption of the National Qualification Framework in Bulgaria:
- **independence and responsibility;**
- **learning competence;**
- **communication and social competencies;**
- **professional competencies.**

3. Competence Dictionaries

3.1. Workitect Competency Dictionary

The Workitect Competency Dictionary with definitions and observable behaviors that may indicate the existence of a competence, contains thirty-five competences in three clusters: competences dealing with people; competences dealing with business and competences dealing with self-management (Figure 1).
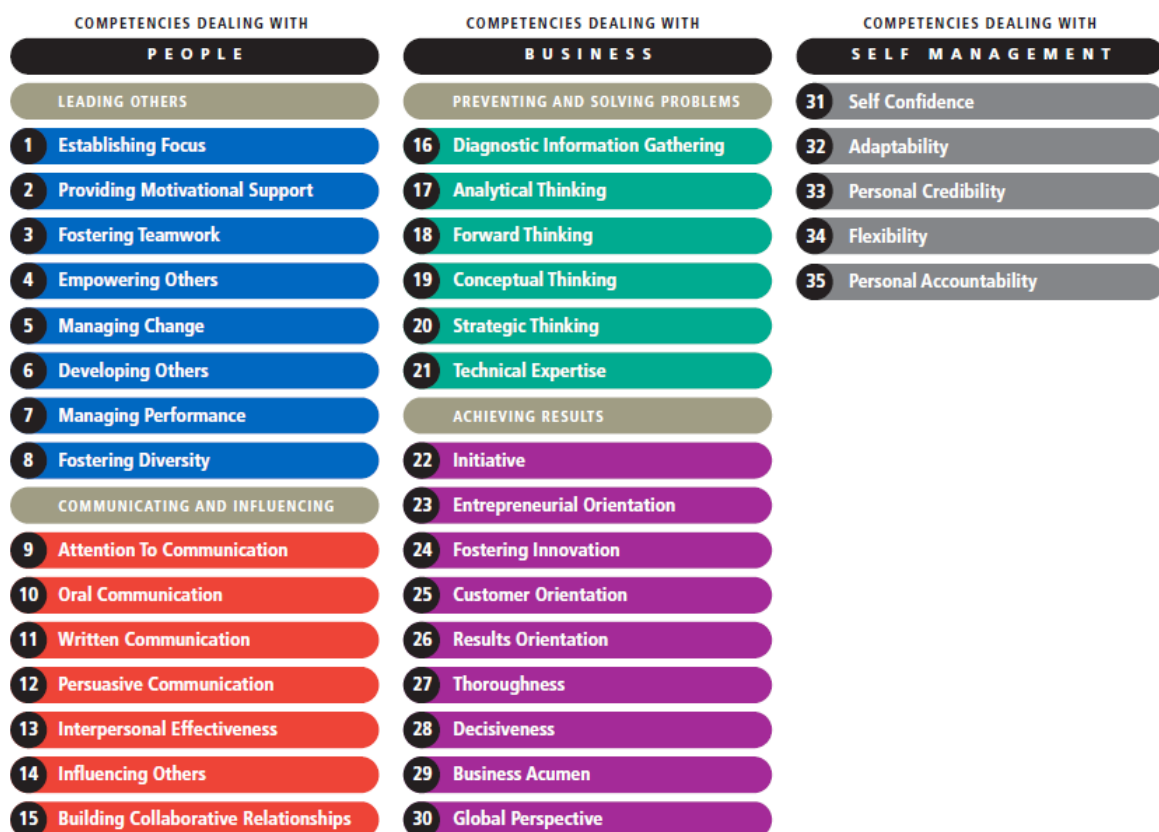

Figure 1 Workitect Competency Dictionary thirty-five competencies
(http://www.workitect.com/PDF/CompetencyDictionary.pdf)

3.2. G-COMPS

Georgia's competency dictionary for workforce planning. G-COMPS provides a consistent framework for state agencies to determine the competencies required for a particular job, and appraise the current and future competency levels of their workforce (www.spa.ga.gov/pdfs/wfp/G-COMPS.pdf).
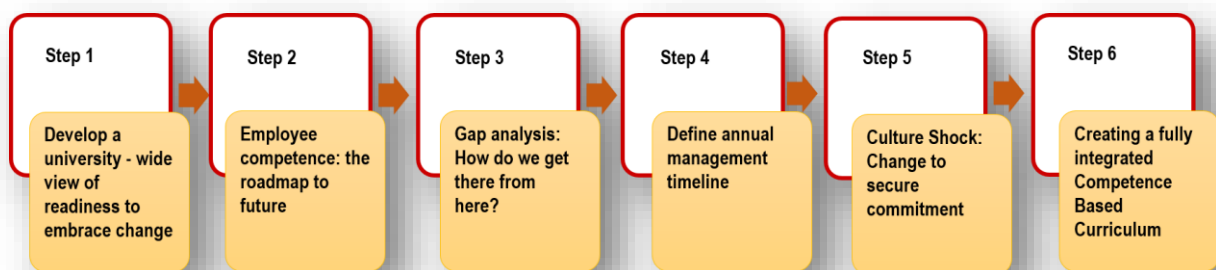
3.3. Harvard University Competency Dictionary

(http://campusservices.harvard.edu/system/files/documents/1865/harvard_competency_dictionary_complete.pdf)

4.Methodology for Competence Based Curriculum Development

The proposed systematic methodology for competence based curriculum development consists of six phases: (1) Conceptualisation; (2) Planning; (3) Data collection; (4) Data analysis & Create catalog of competences; (5) Develop competence based curriculum and (6) Develop applications & Pilot test.

The development of a competence-based curriculum begins with building a successful strategy. The process illustrated in Figure 1 consists of two parts: Part I, comprising steps 1 to 5, where the readiness of the university to transition from a traditional content and time based curriculum to competence based curriculum is assessed, and Part II - translating the strategy into a Competence Based Curriculum.

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Develop a university - wide view of readiness to embrace change	Employee competence: the roadmap to future	Gap analysis: How do we get there from here?	Define annual management timeline	Culture Shock: Change to secure commitment	Creating a fully integrated Competence Based Curriculum

Figure 2 Building a successful competence based curriculum strategy steps

The next step is concerned with identification and description of the competencies that students should acquire or to describe the final attainment levels of the educational program in terms of competencies. The competences is obtained as result of researching the existing economic sector competence models and job profiles. Typically, this activity is performed by a heterogeneous team, consisting of stakeholders such as curriculum developers, teachers, educational managers, field experts and branch representatives. Together they analyse and collect information about the competences within the domain of interest, identify the competencies, and describe them in a competence map. This is a highly complex and difficult processes, as all processes of curriculum development are. It is obvious that a competence profile has important implications, since it constitutes the basis of a competence-based curriculum.

The Methodology for Competence-Based Curricula Development is graphicaly presented in Figure 3. The methodology promotes continuous improvement through the consideration of the university strategic plans. It is based on the intensive research and needs analysis of the university's competence based curriculum development and training.

Workforce requirements

Economic sector competence models Job Profiles

ICT Environment

University Policy & Vision

Pedagogy

Curriculum & Assessment

ICT Integration

Management

Teacher Development

Re-designing organizational policy and curricula

Implementation

Evaluation & Improvement

1 Conceptualisation

1.1. Think through the business needs
1.2. Clarify the policy and curricula re-design with the key stakeholders
1.3. Develop strategy
1.4. Gain support for the pilot

2 Planning

2.1. Working meeting with the key staff
2.2. Review concept; develop plan & timeline
2.3. Identify and agree on people needed for the team
2.4. Define roles and responsibilities
2.5. Create and launch communication plan

3 Data collection

3.1. For each job or job family develop technique to be used for data collection:
- economic sector models analysis
- expert panel
- structured interviews
3.2. Schedule and conduct data gathering events

4 Data analysis Create catalog of competences

4.1. Analyse information obtained.
4.2. Create catalog of competences tailored to a certain university programme
4.3. Describe each competence by definition, behaviors and levels.
4.4. Conduct gap analysis.

5 Develop competence based curriculum

5.1. Match competences and learning objectives / outcomes
5.2 Conduct course design
5.3. Develop:
  - Learning activities
  - Assessment
  - Knowledge resources
5.4. Review with key leaders

6 Develop applications

6.1. Establish teaching & learning technological infrastructure
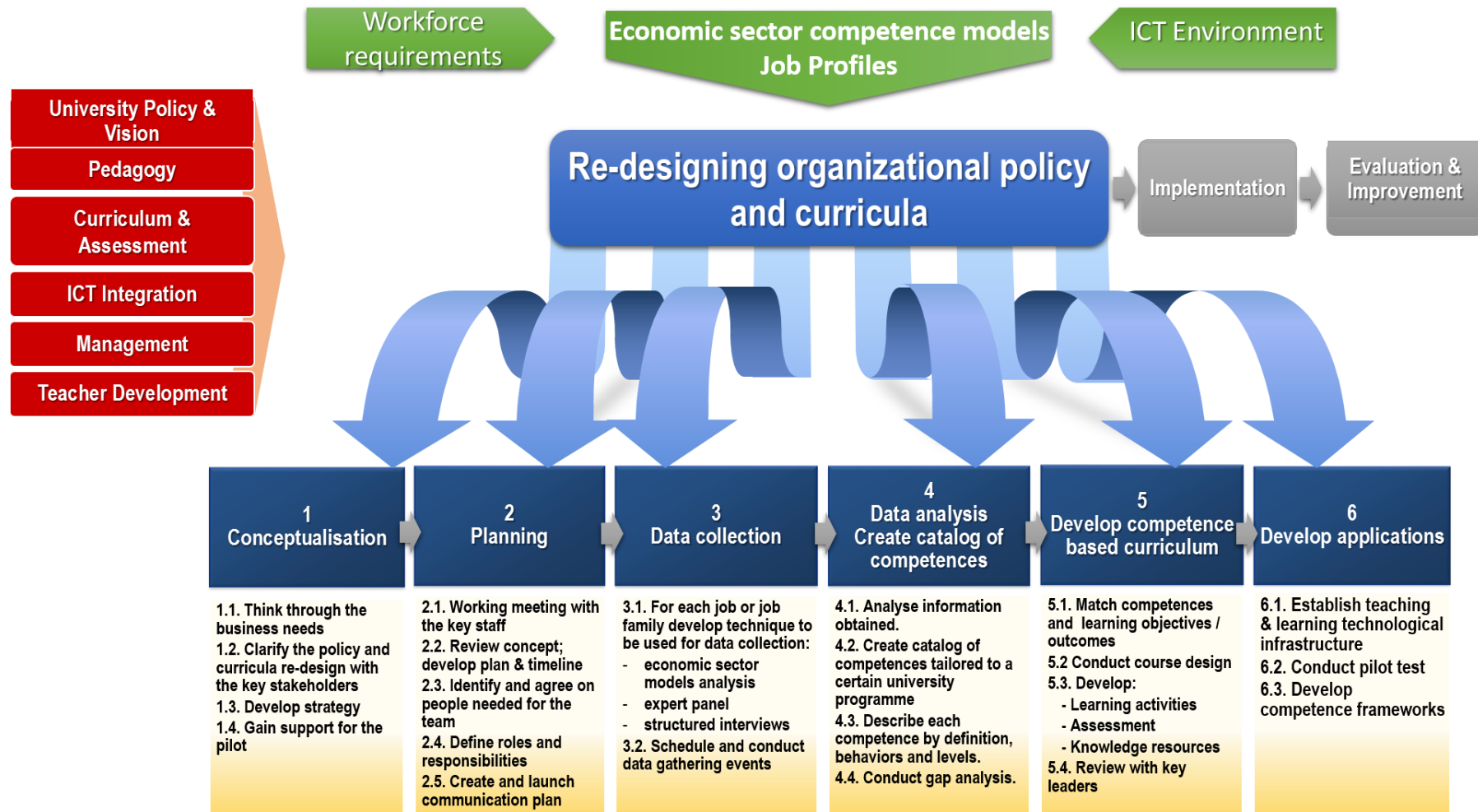6.2. Conduct pilot test
6.3. Develop competence frameworks

Figure 3 Systematic approach for competence based curricula development

5. Frameworks and Data Collection Tools

5.1. The European Qualifications Framework for lifelong learning (EQF)

The EQF is a common European reference framework acting as a translation device to make qualifications acquired within the different education and training systems in Europe more readable and understandable. It has two principal aims: to promote citizens' mobility between countries and sectors, and to facilitate their lifelong learning. The European Qualifications Framework was developed in the years 2004-2007 and formally adopted as a Recommendation by the European Parliament and Council on 23 April 2008. The eight EQF reference levels are described in terms of learning outcomes. The EQF recognises that Europe's education and training systems are so diverse that a shift to learning outcomes is necessary to make comparison and cooperation between countries and institutions possible. In the EQF a learning outcome is defined as a statement of what a learner knows, understands and is able to do on completion of a learning process. The EQF therefore emphasises the results of learning rather than focusing on inputs such as length of study. Learning outcomes are specified in three categories – as knowledge, skills and competence.

Figure 4 EQF Adaptation Support Portal

This signals that qualifications – in different combinations – capture a broad scope of learning outcomes, including theoretical knowledge, practical and technical skills, and social competences where the ability to work with others will be crucial. (EQF Adaptation Support Portal http://www.eqf-support.eu/).

In order to get unified views, it is important to give some widely accepted definitions of terms that will be more likely than others to appear during continuation of work on the project, which is part of a general European Qualification Framework:

Qualification means the formal name for the result of a process of assessment and validation, which is obtained when a competent body determines that an individual has achieved learning outcomes to the standards laid down.

Learning outcomes are statements of what learning pupil / student / person knows, understands and can perform, based on the completion of the learning process, defined by knowledge, skill and competence.

Knowledge means the result of the adoption of information through the learning process. Knowledge is a set of facts, principles, theories and practices related to area of work or study. In the context of the European Qualifications Framework for lifelong learning knowledge is described as theoretical and / or factual.

Skills are the ability to apply knowledge and use the principle of "know how" to perform a specific task and to solve the problem. In the context of the European Qualifications Framework, skills are defined as cognitive (involving the use of logical, intuitive and creative thinking), practical (including physical skill and use of methods, materials, devices and instruments) and social skills (communication and cooperation skills, emotional intelligence and other).

Competence means the ability to apply knowledge, skills and personal, social and methodological skills in the workplace or during learning, as well as in personal and professional development. In the context of the European Qualifications Framework competences are described as responsibility and independence.

5.2. The European e-Competence Framework

The European e-Competence Framework (e-CF) provides a reference of 40 competences as required and applied at the Information and Communication Technology (ICT) workplace, using a common language for competences, skills and proficiency levels that can be understood across Europe.

Its purpose is to provide general and comprehensive e-Competences specified at five proficiency levels that can then be adapted and customised into different contexts from ICT business and stakeholder application perspectives. The 40 competences of the framework are classified according to five main ICT business areas (PLAN – BUILD – RUN – ENABLE – MANAGE) and relate to the European Qualifications Framework (EQF) levels 3 - 8. Current version is the European e-Competence Framework 3.0, A common European framework for ICT Professionals in all industry sectors.

The European e-Competence Framework version 3.0 (CWA 16234) is published in four parts, which may be downloaded free of charge from the CEN website (www.cen.eu) or the e-CF website: www.ecompetences.eu. Part 1 (The Framework), Part 2 (User guidelines) and Part 4 (Case studies) are available in English, German, French and Italian versions. The European e-Competence Framework is a component of the European Union's strategy on «e-Skills for the 21st Century». It is also supporting key policy objectives of the «Grand Coalition for Digital Skills» launched in March 2013. It is promoted as a very useful tool to boost digital skills and the recognition of competences and qualifications across countries and to foster ICT professionalism in Europe. The European ICT Professional Profiles (CWA 16458:2012) is a set of 23 profiles, which may be used for reference or as a starting point to develop further

profiles. This document can also be accessed (free of charge) via the CEN website and the e-CF website.

Figure 5 ICT profile „B.6. Systems Engineering" user generated

5.3. Competence Assessment Information System MyCompetence

MyCompetence (http://en.mycompetence.bg) is created within a project "Development of a Workforce Competence Assessment System by Sectors and Regions" carried out by the Bulgarian Industrial Association (BIA) in partnership with the Confederation of the Independent Trade Unions in Bulgaria (CITUB) and the Confederation of Labour „Podkrepa" and the financial assistance of the European Social Fund.

MyCompetence's objectives are:
- to create functional compatibility and possibilities for integrated data usage

- to generate and collect in one place information and know-how with regard to managing the implementation process of the competence approach in human capital development
- to support and initiate effective measures (at sector and regional level) for employment and skills development of Bulgaria's workforce
- to incorporate good practices from the implementation of the human resources management process
- to create a library with the possibilities for support of lifelong learning
- to provide relevant materials for the support of lifelong learning
- to allow finding and storing of published documents which can be analysed in order to outline trends and recommendations

Figure 6 MyCompetence home page

The functioning and effectiveness of MyCompetence is ensured by the National competence assessment network which encompasses employers, managers, specialists, consultants, state experts and experts from other institutions.

The main users of MyCompetence are:
- Organisations (managers, HRM specialists, competence assessors)
- Ministries, agencies and other institutions and organisations related to the labour market and the spheres of education, continuous learning, recruitment and employee leasing, career guidance
- Higher education institutions, vocational schools, licensed centres for vocational training
- Organisations providing services in the spheres of recruitment, management, training and development of human resources
- Workers and employees legally employed by organisations
- Students.

The main elements of MyCompetence are:
- Module „Sector models"

- Module „Competence assessment"
- Module „Economic sectors information"
- Module „E-learning"
- Module „Development resources".

A sector competence model includes:
- A list of key positions in the sector
- A description of the key business processes
- A catalogue of core, managerial and specific competencies typical for the job positions included.

A sector competence model supports improvement in qualifications by providing transparency with regard to the qualifications needed for working as a professional in a particular role in the sector or in a particular organisation. It acts as link between an employer, an employee and a student by describing the competences necessary for workplace success.

The classification used in the development of sector models in the Competence Assessment Information System MyCompetence organises competences in three groups:
- general,
- specific and
- managerial competencies.

General competencies are relevant for all positions within the company and contribute to creating and fostering corporate culture. Specific competencies are necessary for the successful execution of activities related to specific work tasks. Each competency in MyCompetence is described with the following characteristics: name; type (according to MyCompetence's classification, according to National Qualification Framework and according to the name of the cluster to which it belongs); sector definition; recommended level of demonstration; behavioural indicators; ways to acquire the competence; competence assessment tools. Behavioural indicators illustrate how a competency is transformed from an abstract concept into specific, clear and tangible actions which describe the profile of a successful employee/worker employed at a particular position. A four point Likert scale is used to describe the level of manifestation of the competence.

The selection and description of competencies is done according to the qualification levels set out in the National qualifications framework (NQF). Each competency is related via a code to the clusters created in MyCompetence and the respective NQF qualifications.

The model of key positions by sector consists of two main components:
- Job description
- Competence framework (a set of required job specific competencies)

Knowledge and skills included in the job description are organised and classified on the basis of specially developed customized MyCompetence classifiers. In addition to education requirements, degrees and education institutions recommended for work in the sector (specific universities and vocational schools) are listed along with the corresponding NQF qualification level.

5.4. The Occupational Information Network O*NET

The O*NET program (http://www.onetonline.org/) is the USA nation's primary source of occupational information. Central to the project is the O*NET database, containing information on hundreds of standardized and occupation-specific descriptors. The database is continually updated by surveying a broad range of workers from each occupation. Information from this freely available database forms the heart of O*NET OnLine, the interactive application for exploring and searching occupations. The database also provides the basis for our Career Exploration Tools, a set of valuable assessment instruments for workers and students looking to find or change careers. The O*NET information is intended primarily for purposes of career exploration, and career planning. In addition, O*NET information is used for various workforce investment purposes, such as writing skills-based job orders or resumes, competency-oriented curriculum development, on-the-job training contracts, and related purposes.
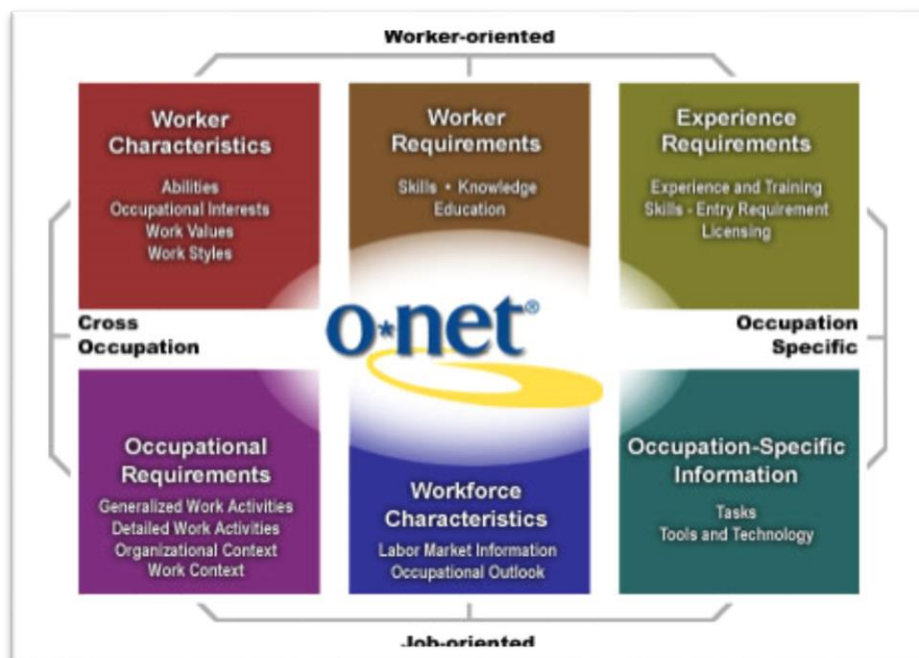
*Figure 7 The O*NET® Content Model*

5.5. European Skills/Competences, qualifications and Occupations

European Skills/ Competences, qualifications and Occupations ESCO (https://ec.europa.eu/esco) is the multilingual classification of European Skills, Competences, Qualifications and Occupations. It identifies and categorises skills and competences, qualifications and occupations relevant for the EU labour market and education and training, in 22 European languages. The system provides occupational profiles showing the relationships between occupations, skills, competences and qualifications. ESCO has been developed in an open IT format and is available for everyone to use free of charge.

What is the added value of ESCO?

To help bridging the gap between the world of education and training and the labour market, the European Commission is developing ESCO. By introducing a standard terminology for

occupations, skills, competences and qualifications ESCO can help education and training systems and the labour market to better identify and manage availability of required skills, competences and qualifications. Its multilingual character facilitates increased international transparency and cooperation in the area of skills and qualifications.

What can ESCO do?
- Facilitate the dialogue between the labour market and the education/training sector.
- Allow employment services to exchange relevant labour market information across borders.
- Facilitate geographical and occupational mobility through semantic interoperability.
- Boost online and skill-based job-matching.
- Help employment services in the shift towards a skills and competences-oriented approach.
- Help describe qualifications in terms of knowledge, skills and competences.
- Enable the development of innovative career guidance services.
- Ultimately: getting more people into jobs throughout Europe!

6. Create Catalog of Competences

A job competence model is a description of those competences possessed by the top performers in a specific job or job family. In effect, a competence model is a "blueprint for outstanding performance". Models usually contain 8-16 competences with definitions, often grouped into "clusters" along with behavioural descriptors.

The key point of the methodology is creating a catalog of competences tailored to a certain university programme the university believes every student should have acquired. Competence behavioural indicators illustrate how a competence is transformed from an abstract concept into specific, clear and tangible actions which describe the profile of a successful learner.

Each degree programme has its own catalog of competences, consisting of a set of general, specific and managerial competencies. The general competences are the same for different graduate degree courses at a particular university. The specific competences will define the actual content and knowledge specific to each graduate of a certain degree programme.

A catalog of competences tailored to a certain university programme can be used in different ways (http://www.link-competences.org/):
- It is the profile of the degree programme and of the future graduate
- It reflects the commitment the university makes to the society, what it proposes as the result of teaching
- It is the guide for course design and all teaching-learning activities, including assessment, within the degree programme
- It is the starting and the end point of the teaching-learning process. Academic courses, subjects and learning activities will be planned with a focus on the learning outcomes which will be assessed in terms of competences.

In order to perform a **gap analysis** a matrix (Table 1) for curricula is developed. In the rows all courses (subjects) of the degree program are listed, while in the columns the desired competences are shown. All courses taught in a program are matched with those competences graduates should have when they finish their studies. In the process of inventarisation of the current curriculum is necessary to translate the traditional learning objectives to the competences.

Table 1 Matching matrix

Competences *Courses/Subjects*	Competence 1	Competence 2…	Competence n
Courses/Subject 1			
Courses/Subject 2			
Courses/Subject m			

The filled matrix is a basis for defining recommendations for curriculum redesigning.

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7. Develop Competence Based Curriculum

The educational standards established in the European Higher Education Area suggest that the aim of universities is to enable their students to acquire competences which fit the study program they intend to complete. To approach teaching and learning based on competences means going beyond knowledge; it means acquiring both the necessary knowledge and the ability to use that knowledge in a specific context.

The goal of competence based curriculum design is to ensure that learners will be able to demonstrate their learned competences after they have acquired a necessary combination of knowledge, skills, and abilities. Students acquire these competences through learning activities. The learning activities must be related to the contents of the studies undertaken. In short, the learning references are the competences and their behavioural descripors that must be attained through learning activities carried out during the study period. Those activities deal with the knowledge resources, which is the raw material of learning. Hence, the core of the competence based framework is a clear and applied definition of competences and their effective link to the learning activities.

Delivering competences to learning objectives/outcomes starts with a catalog of competences. Implicitly, the catalog of competences contains the behavioral indicators which can serve as assessment criteria as well. This is because every competence needs to be formulated in assessable terms by name, definition, behavioural indicators and levels. Attaining competences as learning outcomes is a challenge for students. Consequently, the professors need to transmit these competences through the courses. Transporting competences into classrooms is carried out in two levels: overall program design and individual course(subject) design. The overall program design consists of formulating and clustering the competences and then analysing each competence with the aim of breaking it down into different levels of complexity following the EQF.

Example 1: Breakdown of the generic competence "teamwork" into levels of complexity:

Complexity Level 1: Working in teams and assessing the processes that are established and the roles which evolve with the help of an external guide.

Complexity Level 2: Working in teams (including multidisciplinary teams) and assessing the processes that are established and the roles that evolve, independently, and exercising those roles (including leadership), while incorporating modifications resulting from shared reflection.

Complexity Level 3: Teamwork leadership (including teams that are multidisciplinary and/or in international environments) and assessing the processes that are established and the roles that evolve, while incorporating modifications resulting from shared reflection.

Subsequently, a decision must be taken on which specific subject areas of a curriculum will deal with each competence level. An interesting option at this time - which makes a curriculum more integrated and transversal - is to link each competence to more than one subject area and to different times during the curriculum. The table 2 presented below can be used for this purpose:

Table 2 Competences related to the degree programe

Competences related to the program	Competence 1	Competence 2	Competence 3	…….	Competence n
Courses /Subjects					
Course 1	x		x		X
Course 2		x	x		
….					
Course m	x	x			x

Each course taught in a program is matched with those competences graduates should have when they finish their studies. The designing process for course can be initiated.

At the beginning of the learning design process the competence definition is the objective. During the process of learning design the competence behaviors are associated with the learning activities. During the assessment the competence behaviors are used as the measurable indicators of learning progress. After the process, the learning outcome is the extent to which the competence is acquired (Figure 8).
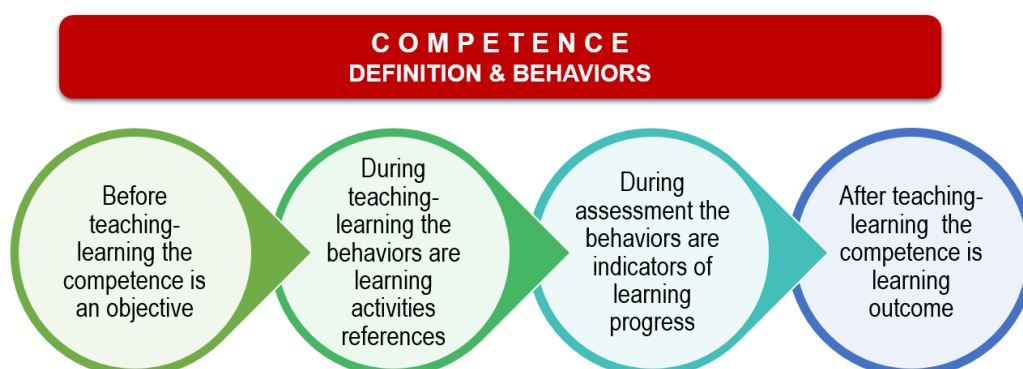

Figure 8 Competence, learning aim and outcome

Each course is structured as a set of Units of Learning. Each Unit of Learning is associated with a specific competence, as shown in Table 3. A Unit of Learning is an abstract term used to refer to any delimited piece of education or training, such as a course, a module, a lesson, etc.

Table 3 Competence related to the Course(Subject) units of study

Competences related to the Course	Competence 1	Competence 2	Competence 3	Competence 4	Competence l
Units of Learnig					
Unit of Learning 1	x				
Unit of Learning 2		x			
					x
Unit of Learning L					

According to the IMS LD Specification, Learning Design is defined as a description of a method enabling learners to attain certain learning objectives by performing certain learning activities in a certain order in the context of a certain learning environment (Figure 9) [2]. Also, LD is described as modeling Units of learning [3]. It is the job of each university professor performing the role of Learning Designer to build each Unit of Learning (scenario) which is based on the specific methods and knowledge resources of the course. It represents more than just a collection of ordered resources to learn - it includes a variety of prescribed activities, assessments, services and support facilities provided by staff members (see Figure 10).
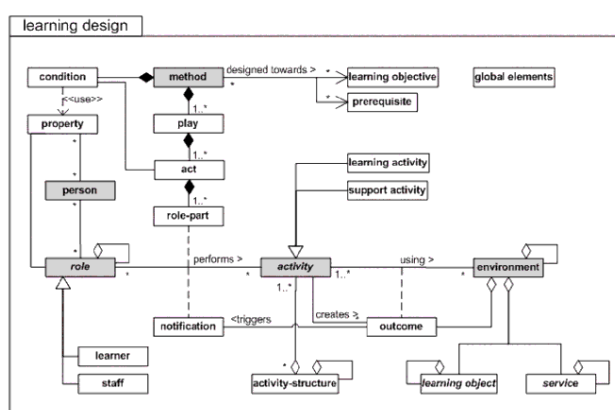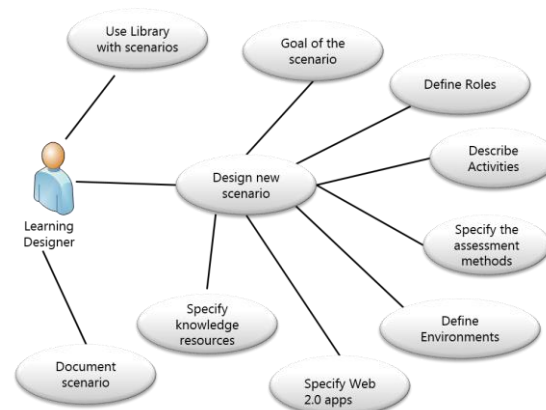

Figure 9 Learning Design Conceptual Modeling

Figure 10 Use Case - building a Unit of Learning

The next step is the creation of learning scenario for each unit learning following the Sample template for describing innovative learning scenarios given in section 8. It is recommended that the range of learning activities in the scenario to match the set of behavioral indicators of competence, as shown in the Table 4.

Table 4 Learning activities design of Module l /unit of study– scenario l

Behavioral indicators related to the Competence L / Learning activities	Behavior L 1	Behavior L 2	Behavior L3	Behavior L4	Behavior..
Activity 1	x	x			
Activity 2		x			
Activity…			x		x

The teaching strategies and didactics need to be applied in such a way that every activity which is done with the students - whether it is an expositional class, a practical, a reading assignment or any other type of individual or group assignments and exercises - is geared towards one of the competences that has to be developed. Further a collaboration among professors of a degree program is essential to guarantee the acquisition of the competences and to improve the coherence of the overall program.

Learning outcomes are simply the levels of competence acquired by students. Competences with their behavioural indicators are the main reference point for the assessment.

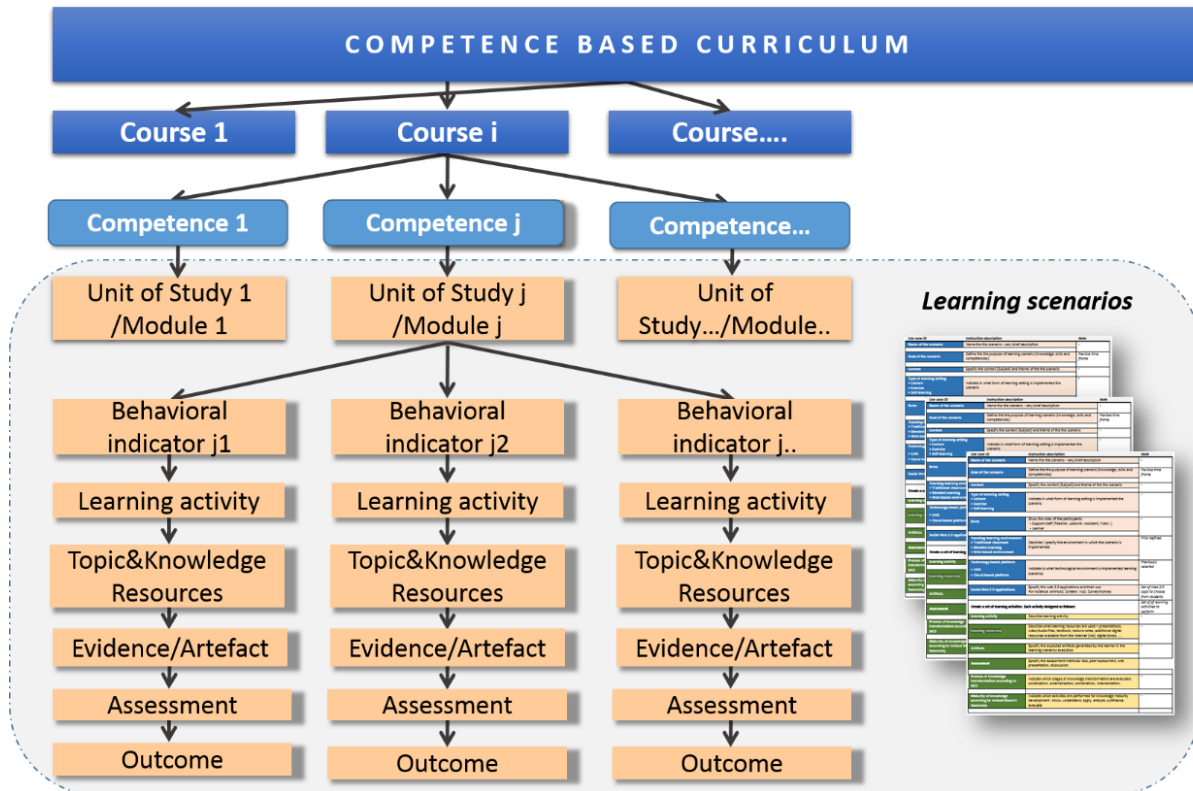The structure of a competence based curriculum is presented in Figure 11.

Figure 11 Competence based curriculm

For example, to develop the competence ANALYTICAL THINKING (Table 5) in the context of Software Engineering Course, it is necessary to perform learning design taking into account the individual behavioral indicators, as shown in Table 6.

Table 5 Example: ANALYTICAL THINKING Competence description

Name	Definition	Behavioral Indicators
ANALYTICAL THINKING	*Approaching a problem by using a logical, systematic, sequential approach*	a) Makes a systematic comparison of two or more alternatives b) Notices discrepancies and inconsistencies in available information c) Identifies a set of features, parameters or considerations to take into account, in analyzing a situation or making a decision d) Approaches a complex task or problem by breaking it down into its component parts and considering each part in detail e) Weighs the costs, benefits, risks, and chances for success, in making a decision f) Identifies many possible causes for a problem g) Carefully weighs the priority of things to be done

Table 6 Sample of matching matrix: ANALYTICAL THINKING behavioural indicators and learning activities

Learning activities / *Behavioral indicators*	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7	Activity 8
Behavior a) *Makes a systematic comparison of two or more alternatives*	**Individual work:**Compare systematic and agile methodology in software engineering **Artefact:** *Create Tables and Concept map with MindMap or Visio, PPT* **Assesment:** *Peer-review and oral presentation to the group*							
Behavior b								
Behavior c								
Behavior d) *Approaches a complex task or problem by breaking it down into its component parts and considering each part in detail*					**Individual work:** Decompose business analysis Body of Knowledge **Artefacts:** diagrams **Assessment:** Test for self-assessment			
Behavior e) *Weighs the costs, benefits, risks, and chances for success, in making a decision*						**Teamwork:** Analyze the challenges, benefits and risks of Cloud Computing infrastructure in the IT Business **Artefacts::** Report, PPT **Assessment:** Test for self-assessment, Peer-review, Glossary		
Behavior f								
Behavior g								

The crucial element in competence based models is the use of criterion-referenced, measurable assessment methods. Competences will be formed in various course units, through different learning activities and assessed at different stages. Indirect assessment approaches gather opinions of the quality and quantity of competences acquired, e.g. through focus groups or surveys. Obviously, the assessment of competences relies upon a certain amount of reflection and reflexivity by respondents. In contrast, direct assessment approaches require that students demonstrate mastery of competences by evaluating actual work completed by the students. This evaluation should ideally be a combination of a performance, formative and summative function. Performance assessments consider the work by students through specific methods, such as tests, oral presentations, and laboratory reports, analyses of texts or e-portfolios. A central part of direct assessments are formative assessments in terms of feed-back provision. Thereby, lecturers comment on how well students have achieved a specific work so far and identify steps for improvement. Each course should contain a summative assessment in which all assessment parts are summarized and reflected in a grade.

The new graduates do not only need basic theoretical knowledge but also a set of competences which allows them to be more versatile when facing new and unknown challenges. In this context the concern of the university stakeholders (especially employees and students) on the effectiveness of the programs taught has increased dramatically. Assessment in higher education is important, since it can provide institutions with crucial feedback which will allow them to improve and develop a student, a program, or a department. For these reasons, universities assess competence gaps between the competencies they teach and the labor market requirements to find how far they are from closing these gaps and how curricula need to be changed to increase the quality, performance and accountability of the education offered. Furthermore, through the assessment of competences students will receive a more transparent education and at the same time learn the necessary skills to become more employable in the future. University employees will be influenced by such an assessment as well since any curriculum change will have an impact on the way how activities – administrative procedures, teaching techniques and materials, personnel selection — are performed within the university. Assessment "should be seen as a means of documenting that institutions are doing what they say they do and that students who complete their programs receive what is promised. The emphasis should be on institutional quality and individual competence".

Learning outcome evaluation forms a central part in a competence based learning model. The assessment of the extent to which competences have been delivered to a student is based on four premises:
• Design assessment at the same time the teaching-learning design gets developed.
• Any learning activity can also be an assessment activity. Teachers consider the best learning activities which can be offered to students in order to support them in the development of competences. Having decided which activities to use, some of them can be chosen to be assessment activities as well. In this way, it is ensured that a clear link between assessment and competence is established, while also being consistent with the concept of continuous evaluation.

- Specific assessment activities can also be included. If the planned assessment deems insufficient, then an activity especially designed for assessment can be introduced in order to minimize the occurred doubts.
- In addition to any continuous assessment, a final assessment of acquisition of the competences can be planned. At the end of each term it may be desirable to verify whether the competences have been delivered successfully to students in a way that they are able to use them in practice. This type of assessment is a powerful tool for assessing the quality of the teaching-learning process.

8. Sample template for describing innovative learning scenarios

Global, social, and technological changes impact higher education in every aspect. Growing number of web 2.0 or the "read/write web", over the last years, are of sufficient force to require universities to alter the process of curriculum creation and teaching and learning. Web 2.0 allows learners to connect, create, collaborate, and share knowledge more rapidly, effectively and efficiently. Social learning, considered as a leading method of spreading knowledge in various environments, focuses on the learning that occurs through interactions and collaborations in a community or across a social network within a social context, which can better support both faculties and students in the education and learning process(Figure 9). Web 2.0 tools have the potential for facilitating the kind of skills required in the 21st century, in particular, knowledge management, independent learning, and multimedia communication skills, as well as more traditional skills such as problem-solving, critical thinking and creativity, which are often not taught well in more traditional forms of education based for example on lectures or learning management system.
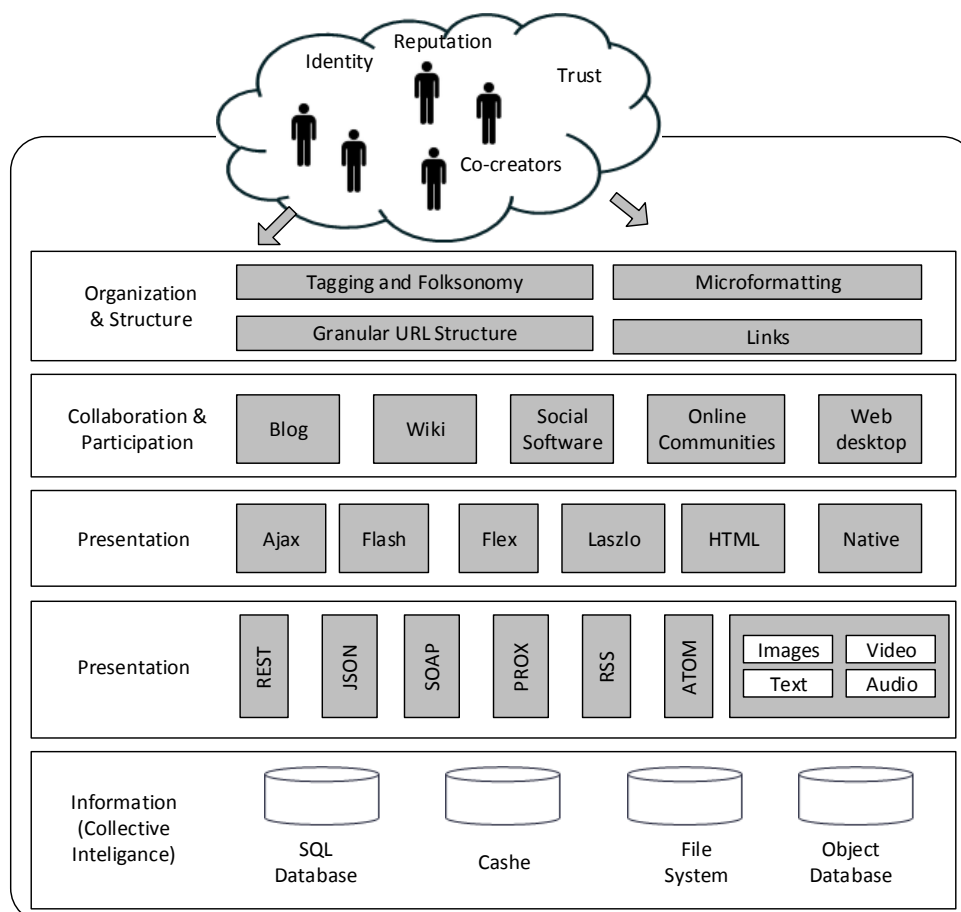

Figure 12 Social computing applications - levels

For the realisation of learning scenarios 2.0 is needed a pre-specification of its components (Table 7).

Table 7 Sample template for describing learning scenarios

Use case ID	Instruction description	Note
Name of the scenario	Name the the scenario - very brief description	-
Goal of the scenario	Define the the purpose of learning scenario (knowledge, skills and competencies)	*Flexible time frame*
Context	Specify the context (Subject) and theme of the the scenario	-
Type of learning setting • **Lecture** • **Exercise** • **Self-learning**	Indicate in what form of learning setting is implemented the scenario	-
Roles	Show the roles of the participants: • Support staff (Teacher, Lecturer, Assistant, Tutor..) • Learner	-
Teaching-learning environment: • **Traditional classroom** • **Blended Learning** • **Web-based environment**	Describe / specify the environment in which the scenario is implemented	*Prior defined*
Technology-based platform • **LMS** • **Cloud-based platform**	Indicate to what technological environment is implemented learning scenarios	*Previously selected*
Social Web 2.0 applications	Specify the web 2.0 applications and their use For instance: Animoto; Screenr; Voci; SurveyMonkey	*Set of Web 2.0 apps to choose from students*
Create a set of learning activities. Each activity designed as follows:		*Set of of learning activities to perform*
Learning activity	Describe learning activity	-
Learning resources	Describe what learning resources are used – presentations, video/audio files, textbook, lecture notes, additional digital resources available from the Internet (link) digital books …..	-
Artifacts	Specify the expected artifacts generated by the learner in the learning scenarios execution	-
Assessment	Specify the assessment methods: test, peer assessment, oral presentation, disscussion	
Process of knowledge transformation according to SECI	Indicate which stages of knowledge transformation are executed: socialization, externalization, combination, internalization.	-
Maturity of knowledge according to revised Bloom's taxonomy	Indicate which activities are performed for knowledge maturity development - know, understand, apply, analyse, synthesise, evaluate	-

According the levels of revised Bloom's taxonomy some of the verbs and assessments are listed in the Table 8

Table 8 Revised Boolm's taxonomy

Level of Taxonomy	Definition	Process Verbs		Assessments	
Creating	Generating new ideas, products, or ways of viewing things	Act Combine Compose Create Design Develop	Generate Improve Invent Imagine Predict Prepare Revise Show, Write	Poem Blueprint Cartoon Collage Film Formula Invention New game	Newspaper Painting Plan Play Song Story Video
Evaluating	Justifying a decision or course of action	Assess Choose Conclude Criticize Debate Defend	Determine Evaluate Justify Prioritize Rate Support, Value	Conclusion Debate Editorial Investigation Judgment Opinion	Recommendation Report
Analyzing	Breaking information into parts to explore understandings and relationships	Classify Compare Contrast Discover Distinguish Experiment	Group Interpret Order Organize Question Research Survey	Chart Checklist Database Illustration Investigation	List Plan Report Summary
Applying	Using information in another familiar situation	Adapt Change Demonstrate Draw Illustrate	List Make Produce Solve Teach Use	Demonstration Diagram Journal Lesson Map Model	Performance Poster Presentation Report Simulation
Understanding	Explaining ideas or concepts	Ask Calculate Convert Describe Discuss	Report Research Review Summarize	Definition Dramatization Example	Quiz Recitation Story Problems Summary
Remembering	Recalling information	Choose Cite, Define Describe Group, Know List	Match Memorize Repeat Select Underline	Definition Fact Label List Quiz	Test Worksheet

There are several important pieces to look at when considering the effectiveness of Web 2.0 technologies on student achievement in a competence based curriculum towards knowledge creation and sharing process (Table 8, Figure 14).
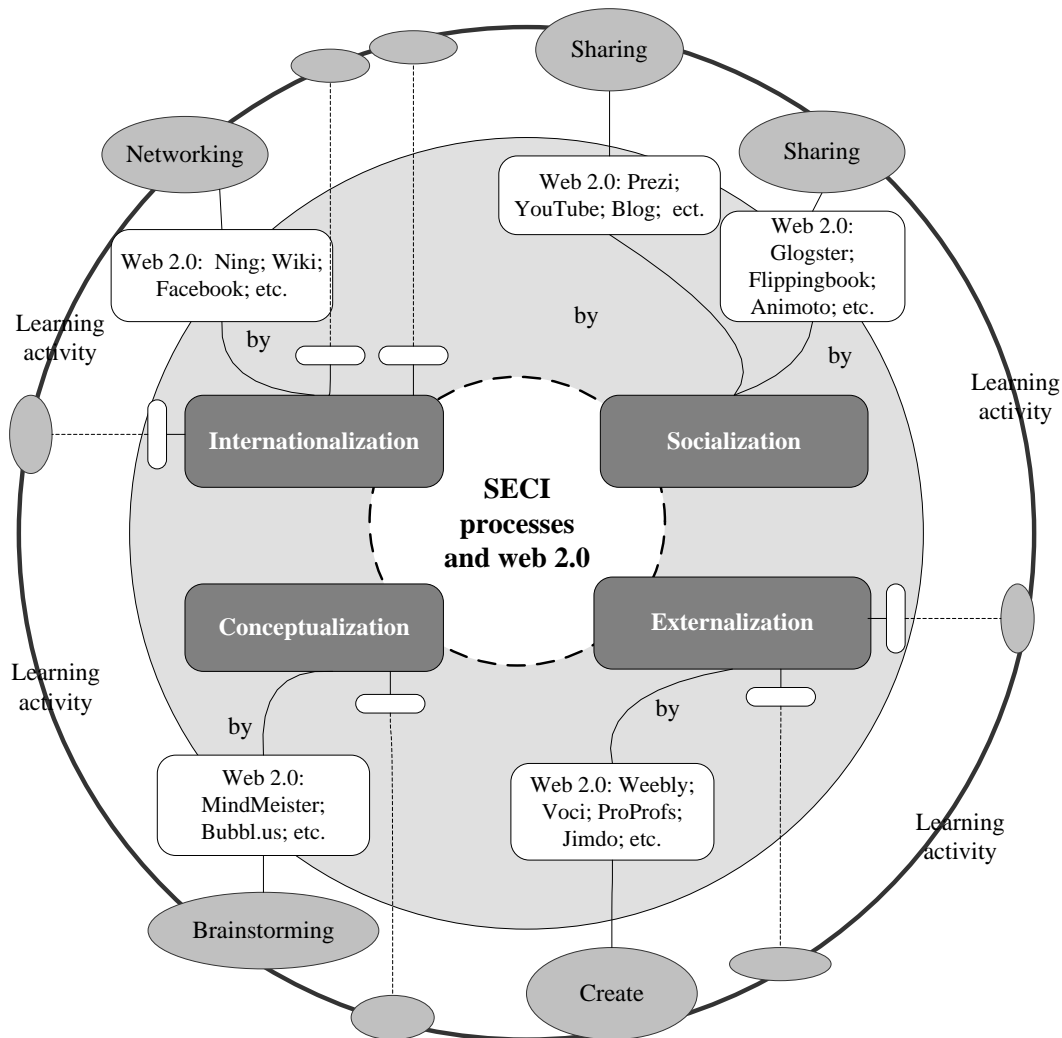

Figure 13 Dynamic interactions between tacit and explicit knowledge enhanced by Web 2.0

The first one is to define Web 2.0 tools supporting the specific SECI processes of knowledge transformation (socialization, externalization, combination, internalization). The second one is to present which learning activity correspond to each one of the process. The third one is to indicate which activities are performed for knowledge maturity development according to the revised Bloom's taxonomy (know, understand, apply, analyse, synthesise, evaluate).

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Association for Computing Machinery (ACM) (http://www.acm.org/), the world's largest educational and scientific computing society, delivers resources that advance computing as a science and a profession - Computer Science Curricula 2013, Curriculum Guidelines for Undergraduate Degree Programs in Computer Science, December 20, 2013 The Joint Task Force on Computing Curricula, Association for Computing Machinery (ACM), IEEE Computer Society (www.acm.org/education/CS2013-final-report.pdf).

ACM provides the computing field's premier Digital Library and serves its members and the computing profession with leading-edge publications, conferences, and career resources. ACM and the IEEE Computer Society have jointly developed new curriculum guidelines for undergraduate degree programs that foster integration of computing with other disciplines. The report, Computer Science Curricula 2013, organizes computer science around 18 Knowledge Areas that reflect the application of computing tools in a wide array of disciplines. It also incorporates new areas of knowledge for computing skills that include information assurance and security, parallel and distributed computing, and platform-based applications.

The report provides best practice curricular models suitable to a broad range of higher education institutions worldwide.

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