

Competence Models in Technology-enhanced Competence-based Learning

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Abstract

Throughout the years competence-based management approaches have proved to be a critical tool in human resource management, vocational training and performance management. As a result, competence-based approaches are often adopted as the key paradigm in both formal or informal education and training programs. Despite this fact, the Technology-enhanced Learning (TeL) research community has only recently considered undertaking research towards technology-enhanced competence-based learning and training. To this end, there exist a number of open issues such as: how can we model competences; how can we assess competences; how can we develop training resources and training activities that target specific competences. The scope of this chapter is to contribute to this field by addressing the issue of competence modeling in technology-enhanced competence-based training, that is, how can we model and represent competence-related information in a system meaningful way.

X.1 Introduction

In recent years, Knowledge Management has become an important issue for businesses and the society in general (Marwick, 2001). Knowledge Management can be seen as a cycle which begins with the discovery of knowledge, typically within an organization; continues with the description of the discovered knowledge in explicit forms; moves to the sharing of the explicitly described knowledge; and finally to the application of the tacit and explicit knowledge in day-to-day operations (Becerra-Fernandez et al., 2004).

The concept of Knowledge Management has been approached from different perspectives (Prusak, 2001; Hong and Stahle, 2005), namely:

- The philosophical and psychological perspective, which aims to target questions such as what knowledge is and where it comes from.
- The organisational and sociological perspective, which addresses key questions such as how we can create and master knowledge in groups, focusing on social networks and communities of practice.
- The economic and business perspective, which addresses key questions such as how to improve, in a cost-effective manner, the impact of knowledge in relation to certain organisational goal achievement.
- The technological perspective, which addresses key questions related with the design, the development and the interoperability of tools for discovering, capturing, sharing, and applying knowledge.

Competence Management is an important research issue within the research framework of Knowledge Management (Draganidis and Mentzas, 2006). Tobias (2006) defines competence management as “to encompass all instruments and methods used in an organization to systematically assess current and future competences required for the work to be performed and to assess available competences of the workforce”. Hamel and Prahalad (1994) anticipated that “with the passage of time, competence management will become more and more important: competence will be well recognized as extremely important for the achievement of company goals, complimentary to, for instance, core business processes, customer relationships, financial issues and so on”.

Within this context, the potential benefits from the adoption of competence management are a combination of organizational and individual benefits (Hustad et al., 2004; TENCompetence, 2007).

From the organizational perspective, a competence-based management approach bares the potential for identifying competence gaps within business units to ensure global competence development in targeted business sections, for designing competence development programmes that target to

group performance improvement, for supporting talent management and enhance human resource potential.

From the individual perspective, a competence-based management approach bares the potential for personal competence development aiming at minimising the gap between available and desired competences within various business sections and beyond, as well as, for discovering previously hidden and/or unknown competences, enhancing possibilities for undertaking new assignments, activities or career paths.

As a result, developing the appropriate competences is a key target for in-company training programs (Kupper and van Wulfften Palthe, 2001). Moreover, formal professional education and training is expected to tune their curricula towards meeting certain professional requirements, so as to appropriately equip their graduates for the labor market. Potential employers anticipate graduates who are able to operate in complex environments, as a result students need learning environments that facilitate their learning to function at the level required for starting a professional career (Weert, 2004; Martin and Willems, 2005).

Within this context, it appears that the results from the accomplishment of learning tasks which support a traditional knowledge-based curriculum are no longer sufficient for these dynamic social and work conditions (Westera, 2001; Boon and van der Klink, 2002). The gap between the knowledge-oriented education and the societal and organizational needs has lead to an increased attention on competence-based learning and training. Competence-based learning refers to the formal and informal learning and training activities that individuals and/or groups perform to improve their competences in a particular field, given some personal, societal or employment related motives (Griffin, 1999; Aspin and Chapman, 2000; Field, 2001).

Consequently, technology-enhanced competence-based learning is attracting the interest of the TeL research community. For example, TENCompetence (www.tencompetence.org) is a European Project which aims to support individuals, groups and organizations in Europe in lifelong competence development by establishing a technical and organizational infrastructure for lifelong competence development. The TENCompetence technical infrastructure is open-source and based on international specifications (Koper and Specht, 2007).

Nevertheless, a number of open issues and challenges for technology-enhanced competence-based learning do exist, such as how can we model competences; how can we assess competences; how can we develop training resources and training activities that target specific competences. The scope of this chapter is to address the issue of competence modeling in technology-enhanced competence-based training, that is, how we can

model and represent competence-related information in a machine-readable meaningful way so as to allow its inter-exchange in a standard and consistent way between different system implementations. This is an important issue in technology-enhanced competence-based learning since it is essential for ensuring the interoperability of these systems. As we will discuss in detail, competence-related information may refer not only to personal information, such as a learner's competence profile, but also to training curricula that were developed by linking training resources and activities with specific competences. In this context, competence models are used to inform the design of appropriate learning activities so as to minimize the gap between the expected competences of a given curriculum and the ones owned by an individual learner.

Following this short introduction to Competence Management and Competence-based Learning, in Section 2 we attempt a literature review on competence and discuss the main elements of a Competence Development Lifecycle, analyzing them through the case study of the TENCompetence Project. This discussion leads us to the need for a unified definition of competence, which can serve as the basis for developing a common Competence Model within the Competence Development lifecycle. As a result, we propose a unified definition of competence based on the analysis of the most widely referenced definitions of competence as they appear in the literature. Next, in Section 3, we discuss the concept of Competence Modeling, we identify the elements that a generic competence model ought to include based on the dimensions of the unified definition of competence proposed in Section 2, and we demonstrate its use in a real case study, namely the EuroPass Language Passport. Then, in Section 4 we discuss the current initiatives on the standardization of competence-based information, namely the IMS RDCEO (IMS RDCEO, 2002), IEEE RCD (IEEE P1484.20/D01, 2004) and HR-XML (HR-XML, 2006) specifications, present a mapping between the elements of these specifications and offer initial discussion on their ability to meet the overall needs of competence modeling, as identified in Section 2. Finally, we discuss our conclusions from the investigation of this topic.

X.2 The concept of competence

X.2.1 Historical origins

The concept of competence has a long history. The early Romans already practiced a kind of competence profiling towards the selection of the "good Roman soldier" (Mayoral et al., 2007). The Chinese Empire, for

three thousand years, recognized differences in individual abilities beyond formal education by adopting civil service exams for the selection on government jobs (Hoge et al., 2005). In Medieval Times, apprentices were expected to develop specific skills they would be needed for effective job performance, as defined by the master craftsman (McLagan, 1997). For hundreds of years, educators have defined the knowledge and skills to be covered in their curricula.

In recent years, McClelland in his seminal paper, "Testing for Competence Rather Than for Intelligence" (McClelland, 1973), introduced the concept of competence into the human resources literature. His work was developed within the context of United States Information Agency efforts to improve their personnel selection procedures. In his research, McClelland proposed numerous competences, such as interpersonal sensitivity, cross-cultural positive regards and management skills that distinguish superior from average officers.

Today, competences are proved to be a critical tool in human resource management, vocational training and performance management (Lachance, 1999; Lucia and Lepsinger, 1999; Sanghi, 2004; Hoge et al., 2005; Otto, 2007).

- In human resource management, competences can be used as part of the criteria to select the most appropriate available person for a given task in hand. Competence-based selection is driven by the assumption that achieving a closer match between the requirements of the task in hand and an individual's competences will result in higher job performance and satisfaction.
- In vocational training, competences can be used as the drivers for the design of appropriate learning resources and activities, the selection of appropriate learning material, processes and eventually curricula that bare the potential to eliminate the gap identified between competences needed and those available. This is important for the adoption for on-demand training.
- In performance management, available competences and obtained results within the context of given tasks can be processed to maintain records that connect them in meaningful ways.

However, despite the fact that competences are an important tool for various fields of application, the research community has not agreed to a commonly accepted definition of the term resulting to multiple interpretations (Boon and van der Klink, 2002; Delamare and Winterton, 2005; Winterton et al., 2005; Sanchez-Ruiz et al., 2006). Furthermore, there is some confusion and debating concerning the difference between competence and competency. Some authors use the term competencies as the plural of the term competence or treat the two as synonymous. Others argue that com-

petency in the American sense complements competence as used in the UK occupational standards (Boon and van der Klink, 2002; Delamare and Winterton, 2005; Winterton et al., 2005; Sanchez-Ruiz et al., 2006). However, it is evident that competencies are only a subset of the required competences for a given professional and/or academic field (Cheetham and Chivers, 2005). In this chapter, we use competency as a synonym of the term “skill” which is only a part of our adopted competence definition.

In the next section we review the most widely referenced definitions of competence as they appear in the literature. Table 1 and 2 presents these definitions which were selected to provide the different perspectives of the term towards building a global understanding of the field and identifying the different issues that it involves.

X.2.2 Competence definition: a literature review

The word competence is derived from Latin word “Competere” which means to be suitable (Onrec, 2007). The competence concept was originally developed in Psychology referring to the individual’s ability to respond to certain demands placed on them by their environment. In the tables below, we present the main definitions of competence from different authors and from different application fields, in an effort to provide a thorough understanding of the different aspects that this term involves. To this end, Table 1 presents examples of competence definitions in human resource management, while Table 2 presents examples of competence definitions in vocational training and education.

Competence Definitions – Human Resource Management

Author	Definition
McClelland (1973)	The knowledge, skills, traits, attitudes, self-concepts, values, or motives directly related to job performance or important life outcomes and shown to differentiate between superior and average performers.
Spencer and Spencer (1993)	An underlying characteristic of an individual that is casually related to criterion-referenced effecting and/or superior performance in a job situation. Competences can be distinguished into essential, competences which serve as the foundation of knowledge and skills needed by everyone and differentiating competences, which are used to distin-

Competence Definitions – Human Resource Management	
Author	Definition
	guish superior performance from average performance and they may include characteristics such as self-concepts, traits and motives.
Lachance (1999)	An underlying characteristic of an employee (i.e., a motive, trait, skill, aspects of one's self-image, social role, or a body of knowledge) which results in effective and/or superior performance.
Treasury Board of Canada Secretariat (1999)	Knowledge, skills, abilities and behaviors that an employee applies in performing his/her work and that are the key employee-related levers for achieving results that are relevant to the organization's business strategies.
Joint Nature Conservation Committee (1999)	A term that describes the range of knowledge, skills, behaviour, attitude and abilities an individual brings to a specific area of a job, such as team working.
Intagliata et al. (2000)	Competences provide organizations with a way to define in behavioral terms what their leaders need to do to produce the results the organization desires and do so in a way that is consistent with and builds its culture.
United Nations Industrial Development Organization (2002)	A set of skills, related knowledge and attributes that allow an individual to perform a task or an activity within a specific function or job.
Sinott et al. (2002)	A characteristic of an employee that contributes to successful job performance and the achievement of organizational results. These include knowledge, skills, and abilities plus other characteristics such as values, motivation, initiative, and self-control.
Missouri Library Association (2005)	An underlying characteristic of an individual that is directly related to effective or superior performance in a job. Differentiating competences distinguish superior from average performer.
Cheetham and Chivers (2005)	Overall, effective performance within an occupation, which may range from the basic level of proficiency to the highest levels of excellence. A competence consists of four main components, namely, knowledge/cognitive competence, functional com-

Competence Definitions – Human Resource Management

Author	Definition
	<p>petence, personal or behavioral competence and values/ethical competence. Knowledge/cognitive competence is defined as “the possession of appropriate work-related knowledge and the ability to put this to effective use”. Functional competence is defined as “the ability to perform a range of work-based tasks effectively to produce specific outcomes”. Personal/behavioral competence is defined as “the ability to adopt appropriate, observable behaviors in work-related situations”. Values/ethical competence is defined as “the possession of appropriate personal and professional values and the ability to make sound judgments based upon these in work-related situations”.</p>
Tobias (2006)	<p>The cognitive (e.g. knowledge and skills), affective (e.g. attitudes and values), behavioral and motivational (e.g. motives) characteristics or dispositions of a person which enable him or her to perform well in a specific situation.</p>
International Board of Standards for Training, Performance and Instruction (2006)	<p>An integrated set of skills, knowledge, and attitudes that enables one to effectively perform the activities of a given occupation or function to the standards expected in employment.</p>

Table 1. Examples of competence definitions – human resource management

Competence Definitions – Vocational Training and Education

Author	Definition
Voorhees (2001)	<p>A combination of skills, abilities and knowledge needed to perform a specific task.</p>
Kupper and van Wulfften Palthe (2001)	<p>The capability of people to perform in a function or a profession according to the qualifications they have. These qualifications should be expressed in terms of knowledge, skills and attitude.</p>
Eurydice (2002)	<p>The ability to perform a particular task.</p>
Friesen and Anderson	<p>The integrated application of knowledge, skills, values, experience, contacts, external knowledge re-</p>

Competence Definitions – Vocational Training and Education	
Author	Definition
(2004)	sources and tools to solve a problem, to perform an activity, or to handle a situation.
Sanchez-Ruiz et al. (2006)	A dynamic combination of knowledge, understanding, skills and abilities.

Table 2. Examples of competence definitions – vocational training and education

X.2.3 Competence development

Competence development can be seen as a lifecycle which aims at the continuous enhancement and development of an individual's or a group's competences. The main steps of this lifecycle can be identified as follows: (a) the creation of a competence model through the identification of required job and task roles and relevant competences, (b) the assessment of existing competences, (c) the gap analysis between existing competences and the required competences for a specific job or task role, (d) the definition of competence development programmes or units of programmes to minimize the identified gaps and (e) the continuous performance monitoring and assessment to confirm improvement (Sinott et al., 2002). Recently within the context of the TENCompetence Consortium, Kopper (Kopper, 2006) proposed the TENCompetence domain model which specifies the data classes that will be represented in a competence development support system referred to as 'Personal Competence Manager' (Vogten et al, 2007). The TENCompetence Domain Model defines the basic concepts of the Competence Development Lifecycle and their relationships.

Competences are anticipated to be modeled in the TENCompetence domain model as follows. Each learning network has a *competence map* that contains a series of competence profiles for roles, functions and jobs. A *competence profile*, which is an instance of a certain competence model, contains one or more *competences* that must be attained in order to meet the demands of the profile. Each profile can have various function levels (e.g., the roles of junior seaman, captain, navigating officer). The evidences that an actor needs to demonstrate as a proof of the mastering a certain competence profile are rather formal (e.g. diploma, license, certification). These formal profiles are agreed upon in certain communities like a professional association or a government.

Nevertheless, job profiles are changing over time, due to the fact that the underlying job requirements are changing or that the perceptions on the

jobs are changing. In the TENCompetence framework, the technical infrastructure that facilitates capturing the competence profiles of a community is called *competence observatory* (Zervas and Sampson, 2007). The results of the observatory should be represented in an interoperable manner. Also competence profiles that are created within a learning network should be exported to the competence profile observatory for further monitoring and decisions. Competence element changes within certain profiles are essential to 'keep-up-to-date both the available and the required competences for a certain role, job or function'. When a new competence is defined, the actors who attained the profile will be informed that a new competence is available (or required) for the profile.

From the above discussion, it becomes evident that modeling and representing competence-related information in a machine-readable meaningful way so as to allow its inter-exchange in a standard and consistent way between different system implementations, is an essential element for building technology-enhanced competence-based training systems.

X.2.4 Towards a unified definition of competence

A key observation from the previous section is that one of the core issues for Competence Development is the competence modeling. However, based on the literature review on the competence term definition presented in section 2.2, it is evident that there does not exist a commonly accepted definition of competence, which is essential for developing a competence model. This fact means that, before accepting a unified and generic definition of the term competence, it will be difficult to proceed towards a reliable competence modeling.

Let us assume a person that already has a university degree in Mathematics and he now wants to obtain a degree in Computer Science from another university. Obviously, he does not expect to participate again in classes of subjects that he has already been certified through his previous degree (such as algebra). A reasonable way to pursue this is to compare his competence profile with the competence model that the new university uses to represent the contents of its curricula and prove that the course "algebra" is one of the classes that he has already successfully attained.

It is rather reasonable to expect that training organizations' professionals are able to understand the various instances that were developed using different competence models, ought to the fact that each institute uses its own definition of the term competence, and manually map them. However that could be hardly interpreted by software systems.

As a result, aiming to contribute towards facilitating the communication and interoperability between various competence-based systems, in this chapter we identify the adoption of a unified, generic definition of competence as an essential step. This means that, we need a definition for competence that will be able to accommodate and reconcile all the different ways that the term competence is used in literature. Such a unified generic definition should provide the common ground for developing a generic competence modeling process. This can lead to the creation of multiple instances of competence models using common elements that can be exchanged between systems dealing with competence-related information.

Based on the different issues emerging from the competence definitions presented in section 2.2, in this section we identify three core dimensions of the term competence. Figure 1 represents these three dimensions.

The first dimension is an individual's characteristics, which refer to a set of characteristics such as knowledge, skills, attitudes, abilities, behaviors, traits, values, motives, self-concepts, aspects of one's self-image, social role and/or self-control.

The second dimension is the individual's competence proficiency level. Proficiency levels are used to classify competences at specific levels, according to the performance of the individual when demonstrating the competence by an action. According to the sample of the definitions, the proficiency level may include superior and average performance, effective and superior performance, or a range from the basic level of proficiency to the highest levels of excellence performance of an activity.

The third dimension is the context in which the individual's competence is applied. The context may refer to a specific area of a job, to an occupation or function, to a life outcome, to work-related situations, to a specific situation, or to a specific task.

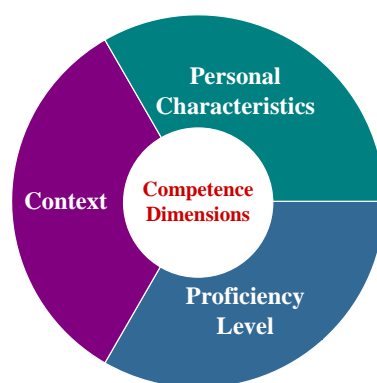


Figure 1. Competence dimensions

Table 3 examines whether the identified dimensions are incorporated in each one of the competence definitions that we recorded in section 2.2 and to what extend.

Authors	Personal Characteristics	Proficiency Level	Context
McClelland (1973)	ü	ü	ü
Spencer and Spencer (1993)	ü	ü	ü
Lachance (1999)	ü	ü	û
Treasury Board of Canada Secretariat (1999)	ü	û	ü
Joint Nature Conservation Committee (1999)	ü	û	ü
Intagliata et al. (2000)	ü	û	û
Voorhees (2001)	ü	û	ü
Kupper and van Wulfften Palthe (2001)	ü	û	ü
Eurydice (2002)	ü	û	ü
United Nations Industrial Development Organization (2002)	ü	û	ü
Sinott et al. (2002)	ü	û	ü
Friesen and Anderson (2004)	ü	û	ü
Missouri Library Association (2005)	ü	ü	ü
Cheetham and Chivers (2005)	ü	ü	ü
Tobias (2006)	ü	û	ü
International Board of Standards for Training, Performance and Instruction (2006)	ü	û	ü
Sanchez-Ruiz et al. (2006)	ü	û	û

Table 3. Relationship between generic competence dimensions and competence definitions

It appears that these dimensions are related to all definitions examined to a certain extend, and thus, for the needs of this chapter we adopt the following generic definition of the term competence: a competence can be de-

defined as a set of personal characteristics (e.g. skills, knowledge, attitudes) that an individual possess or needs to acquire, in order to perform an activity within a specific context. Performance may range from the basic level of proficiency to the highest levels of excellence. Based on this definition, we will next discuss the issue of competence modeling.

X.3 Competence models

In general, model is an abstraction of a concept for the purpose of understanding it before building it. Hence, a competence model can be considered as a generic structure which is applicable beyond the built environment professions. Lucia and Lepsinger (1999) define competence model as “a descriptive tool that identifies the competences needed to perform a role effectively in the organization and help the business meet its strategic objectives”.

For the purpose of this chapter, we suggest that the elements of a competence model should be related to the competence dimensions that we have identified in Section 2.4. These elements are captured in figure 2 and they include:

- **Name:** this element provides a short name of the competence.
- **Description:** this element provides a complete description of the competence.
- **Proficiency Level:** this element aims to describe the proficiency level of the competence. It consists of two sub-elements, namely “level” and “scale”. First, the sub-element “level” aims to describe different types of proficiency level based on the facets of the dimension “Personal Characteristics” (e.g. skills, knowledge, attitudes) discussed in section 2.4. For each characteristic the name of the proficiency level where it belongs, the type and a description of the characteristic must be given. On the other hand, as far as the sub-element “scale” is concerned, different qualitative or quantitative scales may be used in order to represent proficiency levels. The values of the qualitative scales must be represented as an ordered list, while for the quantitative scales the minimum value, the maximum value and the interval must be described.
- **Context:** this element aims is related to the dimension “context” of the unified competence definition captured in figure 1 and it can be described with two sub-elements, namely, “name” and “description”.

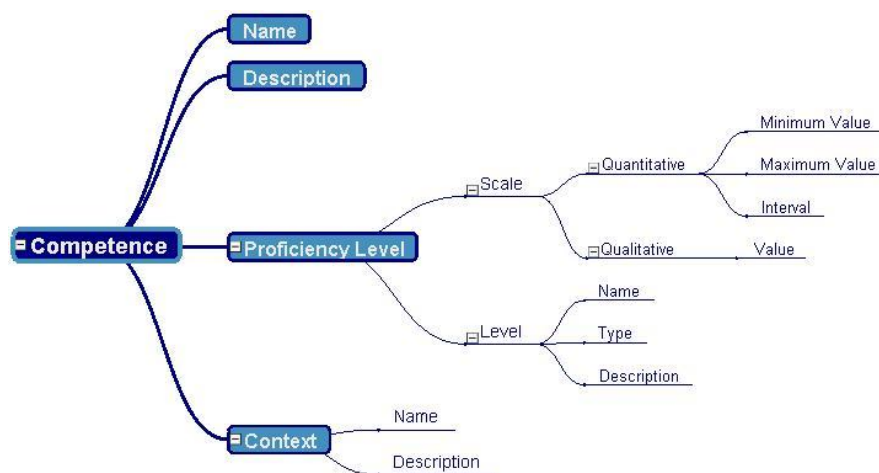


Figure 2. Competence model elements

By assigning certain values to each element of the proposed competence model, then a specific instance of a competence is generated. Next, we demonstrate a real life example of such an instance using the Europass Language Passport. This is the European common model for language competences which was developed by the Council of Europe as part of the European Language Portfolio (European Commission, 2001).

The Europass Language Passport supports the description of language proficiency levels based on a six level scale retrieved from the Common European Framework of Reference for Languages (European Commission, 2001). These levels are: level A1 and A2 for basic users, level B1 and B2 for independent users and level C1 and C2 for proficient users. Furthermore, the Europass Language Passport defines a competence ontology consisting of 5 simple competences and 3 complex competences (that is, any competence consisting of other – simple or complex – competences). Each of these competences is associated (directly or indirectly) with a list of language topics (see Figure 3).

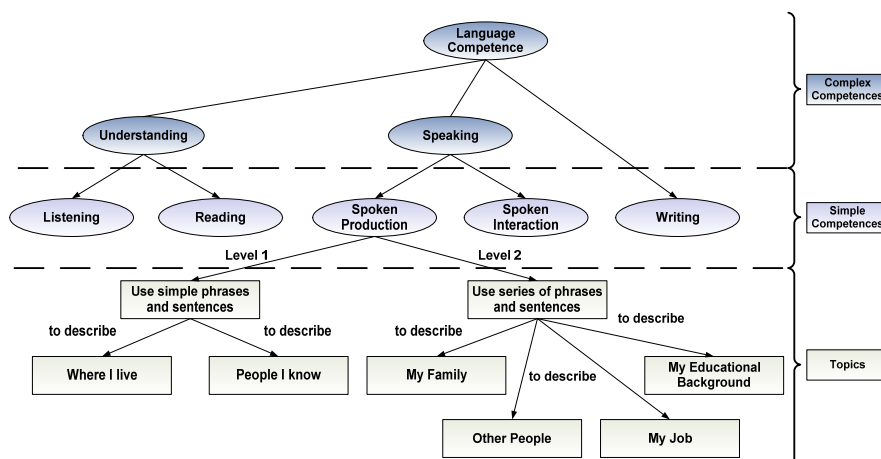


Figure 3. Partial view of competence ontology used in europass language passport

Therefore according to the proposed competence model, an instance based on Europass Language Passport, has the following form:

Name: English Language Speaking

Description: The language user acts alternately as speaker and listener with one or more interlocutors so as to construct conjointly, through the negotiation of meaning following the co-operative principle, conversational discourse. Also, the language user produces an oral text which is received by an audience of one or more listeners.

Proficiency Level

- **Scale**

- o **Qualitative**

- § **Value:** A1

- § **Value:** A2

- § **Value:** B1

- § **Value:** B2

- § **Value:** C1

- § **Value:** C2

- **Level**

- o **Name:** B2

- o **Type:** Knowledge

- o **Description:** Good grammatical knowledge without much sign of having to restrict what he/she wants to say, adopting a level of formality appropriate to the circumstances.

- **Level**

- **Name:** B2
- **Type:** Skill
- **Description:** Can use the language fluently, accurately and effectively on a wide range of general, academic, vocational or leisure topics, marking clearly the relationships between ideas.
- **Level**
 - **Name:** B2
 - **Type:** Attitude
 - **Description:** Willingness to distance oneself from conventional attitudes to cultural difference.

Context

- **Name:** Europe
 - **Description:** Learning and working in Europe
-

In Technology-enhanced Competence-based Learning the process of competence modeling requires appropriate technological infrastructures for storing, organizing, sharing and mapping the various instances of competence models. This is essential for representing competence instances in an interoperable manner using a single, globally agreed format. To this end, international efforts are already in place towards defining specifications for competence descriptions. In the next section, we present and examine these specifications.

X.4 Competence specifications and Discussion

Recently, specifications for competence description, such as the IMS RDCEO (Reusable Definition of Competency or Educational Objective), the IEEE RCD (Reusable Competency Definitions) and the HR-XML Competencies (Measurable Characteristics) have been proposed. These are intended as the means for facilitating interoperability across systems that deal with competence-related information by allowing them to refer to common definitions with commonly recognized values.

The IMS RDCEO specification (IMS RDCEO, 2002) defines an information model for describing, referencing, and exchanging definitions of competences and educational objectives, targeting technology-enhanced competence-based training. Although the IMS RDCEO specification does not intend to offer a solution to the aggregation of complex competences from simple competences, its data model allows the integration of relational information or competence ontologies through embedding additional metadata. Furthermore, the IMS RDCEO specification does not address

the issue of how competences are to be assessed, certified, recorded or used as part of a process with a wider scope, such as Competence Management (IMS RDCEO, 2002).

In the same way, the IEEE RCD specification describes a Competence Definition anticipated to be used in a Learning Management System or referenced in a Competency Profile, by making direct reference of the IMS RDCEO specification (IEEE P1484.20/D01, 2004).

On the other hand, the scope of the HR-XML Consortium is to define a competence description, as well as, to be able to record evidences used to substantiate a competence with ratings and weights that can be used to rank, compare, and evaluate the sufficiency or desirability of a competence (HR-XML, 2006).

In Figure 4, we illustrate the mapping between the elements of the IMS RDCEO and the HR-XML specifications. As we can see both the IMS RDCEO and the HR-XML specifications provide the following elements:

- **Identification:** A globally unique label assigned to identify or classify the competence.
- **Title:** A short name for the competence.
- **Description:** A narrative description of the competence.
- **Definition:** A structured description that provides a more complete definition of the competence.
- **Taxonomy:** The taxonomy where the competence belongs.
- **Personal information:** Information about the individual that possess the competence is described.

while the HR-XML specification further includes elements for:

- **Measurable evidences:** Information used to prove the existence, sufficiency, or level of a competence. Evidences might include test results, certificates, licenses, or a record of direct observation, such as a report given by a former supervisor or other employment reference.
- **Measurable weights:** Information on the relative importance of the competence or the sufficiency required or other type of dimension.

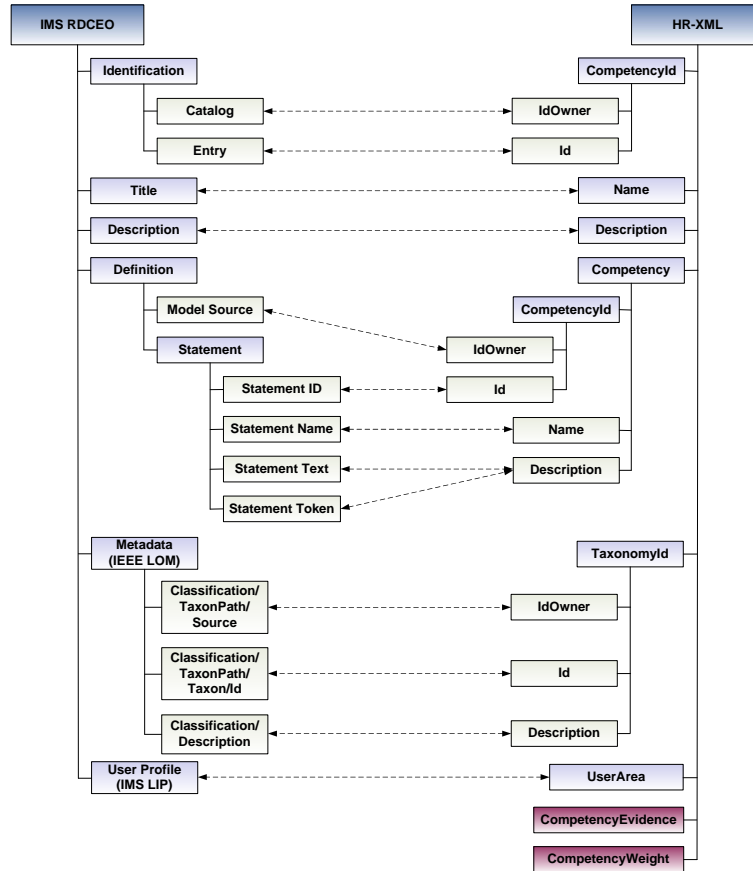


Figure.4. Mapping between IMS RDCEO and HR-XML

Thus, we can observe that both specifications include titles and descriptors that need to be interpreted by human beings, since the information stored within these elements are in a narrative format. As a result, these elements are not directly machine-understandable. Furthermore, both specifications adopt definitions about competence, that do not take into consideration issues such as the “Proficiency Level”, which is important for many definitions of the competence concept as we have seen in section 2.2. Thus, the current scope of these specifications do not address all issues emerging from the competence dimensions identified in the unified definition provided in section 2.4 (Karampiperis et al., 2006; Sampson et al., 2007).

More specifically, according the competence model captured in figure 3, every competence has a name and a complete description. As we can see in figure 5, both specifications include elements for supporting the naming

and the description of a competence, however, this information is stored in a narrative format.

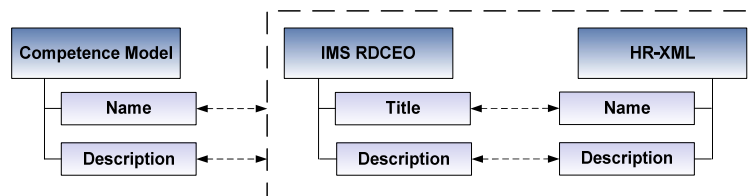


Figure 5. Mapping between competence model and competence specifications (name-description)

On the other hand, according to the competence model captured in figure 3, every competence incorporates various proficiency levels that can be represented via the use of different qualitative or quantitative scales. Furthermore, the characteristics of an individual (e.g. skills, knowledge, attitudes) in relation to a specific competence may differ according the proficiency level of the person.

The IMS RDCEO specification supports the representation of a competence proficiency level, only within the “Title” element. The information stored within this element is in a narrative format, thus, it is not directly machine understandable and limits the potential for systems interoperability. Moreover, the IMS RDCEO specification does not provide a way to capture the values of the scale that is used for the representation of the proficiency level or a way to describe the facets of the dimension “Personal Characteristics” that differentiate based on the proficiency level.

On the other hand, as we can see in figure 6, the HR-XML specification allows the representation of proficiency level information, within the “CompetencyWeight” element. This element contains the “Type” sub-element that is used to specify the type of the competence weight. This sub-element can be related to the “Proficiency Level” in our generic competence model. In addition, the “CompetencyWeight” element contains sub-elements that can be used for the representation of the qualitative or quantitative scales, as it can be seen in figure 6. However in the case of the qualitative scale only the minimum and the maximum value can be described, while it would be desirable to be represented all the values as an ordered list. In addition the HR-XML specification does not provide a way to describe the facets of the dimension “Personal Characteristics” of our generic competence model..

Finally, it appears that both specifications do not include information about the context in their schemas. However, as discussed in section 2, the

context description is an important element for competence modelling and is anticipated to be included in the competence description.

As a conclusion of this section, both specifications, namely, the HR-XML and the IMS RDCEO, have not included in their scope important dimensions of the generic competence model presented in section 2.

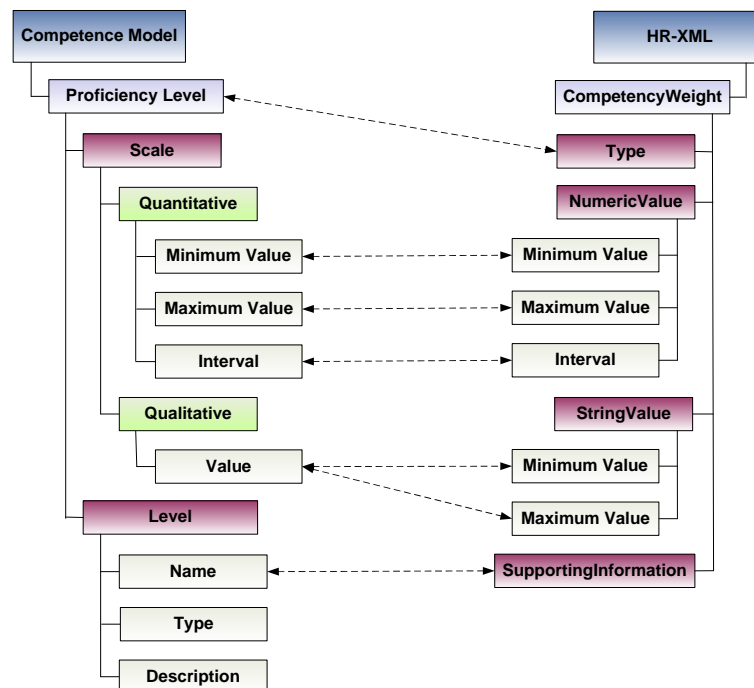


Figure 6. Mapping between competence model and competence specifications (proficiency level)

X.5 Conclusions

Throughout the years competence-based management approaches have proved to be a critical tool in human resource management, vocational training and performance management. As a result, competence-based approaches are often adopted as the key paradigm in both formal or informal education and training programs.

However, despite the fact that competences are an important tool for various fields of application, the communities of researchers and the practitioners have not agreed to a commonly accepted definition of the term

competence, resulting to multiple interpretations. On the other hand, this is essential for developing a generic competence model, as a core step for Competence Development. This is a major drawback for achieving interoperability between various systems that deal with competence-related information.

Within this context, in this chapter we proposed a unified definition of the term competence that is capable to accommodate the different literature definitions and identify three dimensions that can be used for developing a generic competence description model.

In Technology-enhanced Competence-based Learning the process of competence modeling requires appropriate technological infrastructures for storing, organizing, sharing and mapping the various instances of competence models. This is essential for representing competence instances in an interoperable manner using a single, globally agreed format. To this end, international efforts are already in place towards defining specifications for competence descriptions.

Specifications for competence description, such as the IMS RDCEO (Reusable Definition of Competency or Educational Objective), the IEEE RCD (Reusable Competency Definitions) and the HR-XML Competencies (Measurable Characteristics) have been recently proposed. These are intended as the means for facilitating interoperability across systems that deal with competence-related information by allowing them to refer to common definitions with commonly recognized values.

A careful examination of these specifications reveals that they do not include in their scope important dimensions of the generic competence model proposed in this chapter. As a result, it appears that further investigations are in order, so as to facilitate the development of technology-enhanced competence-based training systems.

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References

- Aspin, D. N. & Chapman, J. D. (2000). Lifelong learning: concepts and conceptions. *International Journal of Lifelong Education*, 19(1):2-19
- Becerra-Fernandez, I., Gonzalez, A. & Sabherwal, R. (2004). *Knowledge Management: Challenges, Solutions and Technologies*. Pearson Prentice Hall, New Jersey
- Boon, J. & van der Klink, M. (2002). Competencies: The triumph of a fuzzy concept. *Academy of Human Resource Development Annual Conference*, Honolulu, 1:327-334
- Cheetham, G. & Chivers, G. (2005). *Professions, Competence and Informal Learning*. Edward Elgar Publishing, Cheltenham
- Delamare, F. & Winterton, J. (2005). What is competence? *Human Resource Development International*, 8(1):27-46
- Draganidis, F. & Mentzas, G. (2006). Competency Based Management: A Review of Systems and Approaches. *Information Management & Computer Security Journal*, 14(1):51-64
- European Commission (2001). *Common European Framework of Reference for Languages*. Retrieved December 30, 2007 from http://www.coe.int/t/dg4/linguistic/Source/Framework_EN.pdf
- Eurydice (2002). *Key competencies: A developing concept in general compulsory education*. Retrieved December 30, 2007 from http://www.mszs.si/eurydice/pub/eurydice/survey_5_en.pdf
- Field, J. (2001). Lifelong education. *International Journal of Lifelong Education*, 20(1/2):3-15
- Friesen, N. and Anderson, T. (2004). Interaction for lifelong learning. *British Journal of Educational Technology*, 35(6):679-687
- Griffin, C. (1999). Lifelong learning and social democracy. *International Journal of Lifelong Education*, 18(5):329-342
- Hamel, G. & Prahalad, C. K. (1994). *Competing For the Future*. Harvard Business School Press, Boston
- HR-XML (2006). *HR-XML Consortium Competencies (Measurable Characteristics)*. Retrieved December 30, 2007 from http://ns.hr-xml.org/2_4/HR-XML-2_4/CPO/Competencies.html
- Hoge, M., Tondora, J. & Marrelli, A. (2005). The fundamentals of workforce competency: implications for behavioral health. *Journal of Administration and Policy in Mental Health*, 32:509-531
- Hong, J. & Stahle, P. (2005). The Coevolution of Knowledge and Competence Management. *International Journal of Management Concepts and Philosophy*, 1(2):129-145
- Hustad, E., Munkvold, B. & Moll, B. (2004). Using IT for Strategic Competence Management: Potential Benefits and Challenges. In *Proc. of the European Conference on Information Systems (ECIS)*, Turku, Finland

- IEEE P1484.20/D01, (2004). Draft Standard for Information Technology – Learning Technology – Competency Definitions. Retrieved December 30, 2007 from http://ltsc.ieee.org/wg20/files/IEEE_RDCEO_Spec.pdf
- IMS RDCEO, (2002). IMS Reusable Definition of Competency or Educational Objective. Retrieved December 30, 2007 from <http://www.imsglobal.org/competencies/>
- Intagliata, J., Ulrich, D. & Smallwood, N. (2000). Leveraging Leadership Competencies to Produce Leadership Brand: Creating Distinctiveness by Focusing on Strategy and Results. *Human Resource Planning Journal*, 23(4):12-23
- International Board of Standards for Training, Performance and Instruction (2006). Competencies. Retrieved December 30, 2007 from <http://www.ibstpi.org/competencies.htm>
- Joint Nature Conservation Committee (1999). Biodiversity Information Assistant. Retrieved December 30, 2007 from <http://www.jncc.gov.uk/pdf/job200607.pdf>
- Karampiperis, P., Sampson, D. & Fytros, D. (2006), Lifelong Competence Development: Towards a Common Metadata Model for Competencies Description - The Case Study of Europass Language Passport. In Proc. of the 6th IEEE International Conference on Advanced Learning Technologies (ICALT 2006), 677-681, Kerkrade, The Netherlands
- Koper, R (2006) TenCompetence Domain Model, Retrieved December 30, 2007 from <http://dspace.ou.nl/handle/1820/649/DomainModel-version1p0.pdf>
- Koper, R. & Specht, M. (2007). TenCompetence: Lifelong Competence Development and Learning. In Miguel-Angel Sicilia (Ed.), *Competencies in Organizational E-Learning: Concepts and Tools*. 230:247. Idea Group Publishing
- Kupper, H. & van Wulfften Palthe, A.W. (2001). Competency-Based Curriculum Development: Experiences in Agri Chain Management in The Netherlands and in China. IAMA World Food and Agribusiness Conference, Sydney, Australia
- Lachance, J. R. (1999). Looking to the Future: Human Resources Competencies. United States Office of Personnel Management
- Lucia, A. D. & Lepsinger, R. (1999). *The Art and Science of Competency Models: Pinpointing Critical Success Factors in Organizations*. Jossey-Bass, San Francisco
- Martin, H. & Willems, E. (2005). IT Support of Competence Based Learning in Groups in a Distance Learning Environment. *The electronic Journal of e-Learning*, 3(1):31-40
- Marwick, D. (2001). Knowledge Management Technology. *IBM Systems Journal*, 40(4):814-830
- Mayoral, M. R., Palacios, C. R., Gómez, J. M. & Crespo, A. G. (2007). A Mobile Framework for Competence Evaluation: Innovation Assessment Using Mobile Information Systems. *Journal of Technology Management & Innovation*, 2(3):49-57
- McClelland, D. (1973). Testing for Competence Rather Than for Intelligence. *American Psychologist Journal*, 20:321-333

- McLagan, P. (1997). Competencies: The Next Generation. *Training & Development*, 51(5):40-47
- Missouri Library Association (2005). A Behavioral Approach to Support Staff Development. Retrieved December 30, 2007 from <http://molib.org/Outline.pdf>
- Onrec (2007). Competency Profiling Fits the Bill. Retrieved September 30, 2007 from <http://www.onrec.com/content2/news.asp?ID=12930>
- Otto, T., Riives, J. & Loun, K. (2007). Productivity Improvement through Monitoring of Human Resources Competence Level. B. Katalinic (Toim.). DAAAM International Scientific Book 2007. DAAAM International Vienna.
- Prusak, L. (2001). Where did knowledge management come from. *IBM Systems Journal*, 40(4):1002–1007
- Sampson, D., Karampiperis, P. & Fytros, D. (2007). Developing a Common Metadata Model for Competencies Description. *Interactive Learning Environment, Special Issue on Learning Networks for Lifelong Competence Development*, 15(2):137-150, Routledge.
- Sánchez-Ruiz, L. M., Edwards, M., & Sarrias E. B. (2006). Competence learning challenges in Engineering Education in Spain: from theory to practice. In *Proc. of the International Conference on Engineering Education*, San Juan, USA.
- Sanghi, S. (2004). *The Handbook of Competency Mapping*. Sage Publications, London
- Sinnott, G. C., Madison, G. H. & Pataki, G. E. (2002). Competencies: Report of the Competencies Workgroup. Workforce and Succession Planning Work Groups, New York State Governor's Office of Employee Relations and the Department of Civil Service
- Spencer, L. M. & Spencer, S. M. (1993). *Competence at Work*. John Wiley & Sons: New York
- TENCompetence (2007). M6.1 Templates of the pedagogical models to be used in authoring environment; model that combines classical and new forms of assessment, European Community Information Society Technologies (IST) Programme, Contract 027087
- Tobias, L. (2006). Organizational Competence Management - A Competence Performance Approach. In: 6th International Conference on Knowledge Management (I-KNOW 06), Graz, Austria
- Treasury Board of Canada Secretariat (1999). Framework for competency-based management in the public service of Canada. Report of joint initiative between the Treasury Board of Canada Secretariat and the Public Service Commission
- United Nations Industrial Development Organization (2002). UNIDO Competencies. Retrieved December 30, 2007 from <https://www.unido.org/userfiles/timminsk/UNIDO-CompetencyModel-Part1.pdf>
- Vogten, H., Koper, R., Martens, H., & Van Bruggen, J. (2007). Using the Personal Competence Manager as a complementary approach to IMS Learning Design authoring. *Interactive Learning Environments*.

- Voorhees, R.A. (2001). Competency-based learning models: A necessary future. In R.A Voorhees (Ed.), *Measuring what matters: Competency-based learning models in higher education: New directions for institutional research*, 110:5-13. Jossey-Bass, San Francisco
- Weert, T. J. (2004). ICT-rich and Competency Based Learning in Higher Education. In *Proc. Of The New Educational Benefits of ICT in Higher Education*
- Westera ,W. (2001). Competences in education: a confusion of tongues. *Journal of Curriculum Studies*, 33(1):75-88
- Winterton, J., Delamare-Le Deist, F. & Stringfellow, E. (2005). Typology of knowledge, skills and competences: clarification of the concept and prototype. Centre for European Research on Employment and Human Resources. Groupe ESC Toulouse. Research report elaborated on behalf of Cedefop/Thessaloniki
- Zervas, P., & Sampson, D. (2007). The TENCompetence Observatory: An Enabling Technology for Common Description of Competences, Proceedings of the 7th IEEE International Conference on Advanced Learning Technologies, Niigata, Japan.