

Towards a competency model: A review of the literature and the competency standards

Maryam El Asame¹ · Mohamed Wakrim¹

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Abstract Competency-based approaches using information and communication technologies have been the main solution of the organization's expectations in all fields (public and private) to increase the products' quality and employees' capacity. Furthermore, the concept of competency can have several different definitions, which may make it difficult to model. As a result, without a good representation of the knowledge and competency and reusable definitions of competence, an e- Learning system will be unable to adapt to its users, to personalize learning activities. In this paper, we present a view of some important competency definitions and the main competency specifications, like the HR-XML specification (Human Resources XML), and the IMS Reusable Definition of Competency or Educational Objective (IMS RDCEO). Moreover, we suggest a competency model for training and education based on these specifications.

Keywords Competency model · Metadata model · Skills · IMS RDCEO · HR-xml

1 Introduction

“When designers would like to build a learning design, they should, first of all answer two main questions: The first one is to know exactly which knowledge must be acquired and what are the educational goals, the target competencies for that knowledge are. The second one is how you can organize activities and environment to achieve the best knowledge, competencies and previous objectives.”(Paquette et al. 2006).

✉ Maryam El Asame
mariam.assam@gmail.com

Mohamed Wakrim
m.wakrim@uiz.ac.ma

¹ Engineering Sciences Laboratory, Ibn Zohr University, Agadir, Morocco

Regarding the competency modelling, one of the challenges in defining a metadata model is the many ways that the term “competency” has been used in different sectors and application domains. As a result, without a good representation of the knowledge and competency, an adaptive Hypermedia system will be unable to adapt to its users, to personalize learning activities. According to Brusilovsky (2003) and Cristea (2004) “Adaptive Hypermedia is the solution to the problem of personalization on the Web, especially for Educational Systems that build a model of the goals, preferences and knowledge of each individual user, and use this model throughout the interaction with the user, in order to adapt to the needs of that user”.

In this connection, we need a structural representation of knowledge, competencies, activities and resources, as well as the good association between learning objects within a unit-of-learning.

A competency model can be defined as “a descriptive tool that identifies the competencies needed to perform a role, effectively in the organization and help the business meet its strategic objectives” (Sampson and Fytros 2008). Moreover, in educational resources, metadata refers to information about resources used in the context of learning, education, and training (Vatankhah Barenji et al. 2013).

In this paper, we suggest a competency metadata model, taking into consideration the different literature definitions, the existing works of competency modelling, and international specifications for competency description such as the IMS RDCEO (2002) and the HR-XML (2006).

The paper is organized as follows: Following this introduction, in section 2 we present some definitions and the main elements of competency. In section 3 we provide international specifications for competency description, especially IMS RDCEO and HR-XML. In section 4 we propose a competency model and an example from a real life case study to demonstrate our proposal. The last Section concludes the paper and mentions the future work.

2 The concept of competency

Today, competency is a central concept in various fields of application. But, when talking about competency, we talk about a fuzzy term. In this section we present the main definitions of competency from different authors and from different application fields, and elaborate the key characteristics of competency.

2.1 Competency definition in companies and workplace

According to United Nations Industrial Development Organization competency is a set of knowledge, features and skills that a person needs to accomplish an activity within a specific job (Sampson and Fytros 2008). Le Boterf (2000) points out that an individual or employee is competent if he is able to mobilize the personal and environmental resources to perform a task in a specific situation. The Mayer Committee (Guthrie 2009) and International Board of Standards for Training, Performance and Instruction (Sampson and Fytros 2008) defined competency as a capacity to apply a set of knowledge, skills and attitudes in an integrated way to perform the activities in work situations. In addition, Torkkeli and Tuominen defined competency as the capacity to

integrate and coordinate the various skills to exploit actor's or company's resources (Belkadi et al. 2007).

Missouri Library Association claimed that competency is the basic characteristic of the person that reflects the effective or superior performance in a job (Sampson and Fytros 2008). In other words, Tobias (2006) defines competencies as a set of characteristics or dispositions that can be cognitive, affective, behavioral and motivational which enable a person to perform well in a specific situation. For Drejer competency is a system of human beings that benefit from the hard technology but not in any way, they use it in an organized way. Also, they inspire from the culture to create an output that provides a competitive advantage for the company (Belkadi et al. 2006, 2007).

Competency is not exclusively focused on knowledge or technical skills, but also includes communication or language skills that are necessary for the successful function within society. According to Vatankhah Barenji et al. (2013) there exists three sets of competency within an enterprise; individual competency, enterprise competency and collaboration-oriented competency. Le Diest and Winterton (2005) claimed that competency can be considered as a characteristic value of an organisation or work team, not just the private value of individuals. In other words, it can not rely on an individual's competencies and attributes, except if it had an impact within the work team and that drives the company's performance. Tobias and Dietrich (2003) considered competency as the various individual characteristics like knowledge, skills and abilities which are relatively stable in diverse situations.

2.2 Competency definition in education and professional training

Knowing something or acquiring some learning objectives is not enough. You need to apply certain knowledge with a specific level of performance in a certain context. Thus, Paquette (2002) defines competency as a statement of principle that determines a ternary relationship between a public target or actor, knowledge and a skill. In this way, competency is defined as a relation linking three areas (El Falaki et al. 2010):

- Knowledge: is described by concepts, procedures, principles or specific events which represent domain knowledge.
- Skills: describe the processes that can be applied to domain knowledge so that they can be perceived, remembered, assimilated, analyzed and evaluated. These processes are metaprocesses which present a generic domain independent of the application. In other words, they can be applied to various fields.
- Public Target: describe behavioral skills, characteristics, functions and tasks of actors.

Competency is defined by Kupper and van Wulfften Palthe as the capability of individuals to perform a job or a function according to their qualifications: knowledge, skills and attitude (Sampson and Fytros 2008). Friesen and Anderson (2004) defined competency as the integrated various personal characteristics (values, knowledge, skills, experience, contacts, and tools) to perform a task or activity. For Lasanier a competency is a skill that integrates ability and knowledge which refers to various domains: cognitive, affective, psychomotor and social (Boumane et al. 2006).

Mulder, Weigel and Collins see competency as the capability to use the knowledge, attitudes and skills in an integrated way from professional repertoire of an individual

(Guthrie 2009). Rosemary defines competency as the individual's degree to apply knowledge and skills needed to perform a particular situation within the range of similar situations (Belkadi et al. 2006).

2.3 Key characteristics of competency

We have seen in sub-sections 2.1 and 2.2 several definitions of the concept of competency, thus the following points are the main characteristics of competency:

- Competency is a combination of various resources (knowledge, skills, motives, abilities, expertise, traits, values, etc), which goes beyond a simple possession of these resources.
- Competency is characterized by an integrated series of resources.
- Competency is a process that mobilizes all resources needed to perform a specific task.
- Competency is associated with a certain performance that is ranging from the lowest to the highest proficiency level to classify competency.
- Competency depends on the specific context in which individuals or employees apply their competencies. In other words, a person can be competent in a context but may not be so in a different context.
- Competency is associated with a situation or family of situations, and it depends on the characteristics of these situations to face the difficult problems in academic or personal reality.
- Competency depends on the conditions in which it is activated and on the indicators that must determine the construction of the learning activities and of the training programs.
- Competency is related to an actor that may be, for instance, the company, a project team or an individual.
- Competencies are finalized and are organized in units to attain efficiently a specific objective.
- Competencies describe the activities specified by a function, a role or a particular task, qualified by the level of excellence of the performance observed and validated by a social sanction.

According to the characteristics listed above, we can define the concept of competency as “a set of personal characteristics (skills, knowledge, attitudes, etc) that a person acquires or needs to acquire, in order to perform an activity inside a certain context with a specific performance level”. Therefore, our competency is defined as a quadrilateral (S,K,P,C) where “S” is a generic skill (described by an action verb) from a taxonomy of skills, “K” is the specific knowledge on which the actors can practice the skills, “P” is a combination of performance criteria values and “C” is the context in which the skill is applied.

3 Current competencies specification

The principal goal of IMS RDCEO (IMS RDCEO 2002) and HR-XML (HR-XML 2006) specifications is to propose a way to describe, refer and exchange common

definitions of competencies across E-learning systems. They enable interoperability across these systems. Based on an analysis of these competency standards, we present in this section the main dimensions and remarks to describe competencies.

3.1 IMS RDCEO specification

The IMS Reusable Definition of Competency or Educational Objective (RDCEO) defines a data and information model to describe, reference, and exchange competency definitions, especially for online learning. Additionally, the competency definition includes some elements (knowledge, skills, tasks, and learning results) that describe competency term in a general meaning. This specification suggests a way to use information of competency independently of context. Moreover, it enables interoperability between learning systems.

The information model can be exploited to exchange the definitions among human resource systems, learning systems, learning content, competency or skill referential and other systems. It can rank competencies or educational goals with many different ways, but that is not the role of this specification. Its main objective is to solve the referencing and cataloguing requirement of competency and learning objectives (Paquette 2002).

3.2 HR-XML competency standards

The HR-XML Consortium has produced a library of several interdependent XML Schemas that define the data elements for particular HR transactions, among them the Competencies Recommendation. The HR-XML Consortium develops a competency schema simple and flexible that will be used within diversity contexts. In addition, the competency schema allows the comparison, rank and evaluation of competencies.

Competency can be defined by (HR-XML 2006) “A specific, identifiable, definable, and measurable knowledge, skill, ability and/or other deployment-related characteristic (e.g. attitude, behaviour, physical ability) which a human resource may possess and which is necessary for, or material to, the performance of an activity within a specific business context”. Likewise, competency may be considered as a degree of ability needed to perform an activity. Furthermore, it can be composed of several partial competencies that may be measurable individually and independently.

The HR-XML Consortium proposes nine elements to define competency information: Name, Description, Required, CompetencyId, TaxonomyId, Competency Evidence, Competency Weight, Competency, and UserArea.

3.3 Comparison and remarks

As it is shown in IMS RDCEO documents and discussed in (Karampiperis et al. 2006; Sampson and Fytros 2008; Cicortas et al. 2008), the vital information is presented as an unorganized textual definition of the competency, such as proficiency level, capability, and subject matter (Cicortas et al. 2008). Therefore, machines can face difficulties in searching and processing these elements. In addition, it limits and reduces interoperability between the different systems. Furthermore, RDCEO does not treat how to assess, to certify, to record the competencies or how to use them as part of process like knowledge management or instructional design.

According to (Karampiperis et al., 2006; García-Barriocanal et al., 2012), "the IMS RDCEO needs a way to represent competency grading scale. This lack will affect the assessment of competencies". Moreover, it needs a way when assessing to represent the competency weighting factor of sub-competencies (Karampiperis et al. 2006; Sampson and Fytros 2008).

Based on an analysis of the structure of IMS RDCEO and HR-XML specifications (Sitthisak et al. 2007; Sampson and Fytros 2008; Cicortas et al. 2008; Sampson 2009), we list the following remarks:

- Both specifications provide these elements for describing competencies: Competency identification, Competency title, Competency description, Competency definition, Competency taxonomy, personal information.
- Both specifications do not address all facets of the competency provided in above sections. Furthermore, competency modelling should take into consideration the main elements of competency (skills, knowledge, performance and context).
- Both specifications encompass elements for describing and naming competency, but this description is presented in narrative form. Thus, machines can face difficulties in searching and processing these elements.
- Both specifications do not take into consideration proficiency level. It can not talk about competency or improve it without specifying a level.
- Both specifications do not take into consideration in the competencies schemas a major element in which the individual's competencies are acquired and applied (i.e. a context).
- To measure the performance level, we must use at least both measurement scales: qualitative and quantitative.
- The IMS RDCEO specification does not define the competency's grading scale within competency schema. However, HR-XML presents proficiency level information in the Competency Weight element.

To avoid these limitations we have proposed a model of competency that take taking into consideration, the examination of these specifications and the key dimensions of our competency definition that are (S: skills, K: knowledge, P: performance and C: context).

4 The proposed model and case study

In this section, we propose a competency model that intends to give a tool for describing the competencies of learners who pursue their education and/or training in different domains, so as to develop, maintain and evaluate their own competencies.

In our proposal, competency is based on these core dimensions, the first one is the personal characteristics namely skills and knowledge where the generic skills are applying to a specific domain and acting on knowledge. The second dimension is the competency level that is used to demonstrate the personal's performance. The third dimension is the context in which the individual's competency is applied. To avoid the limitations listed in section 3.3, and to facilitate the interoperability between the different systems, we reserve for each element a specific space. In addition our proposal divides the general competency into specific competencies to help learners to evaluate competencies during the learning process.

More specifically, in our model of learning each training aims to develop learners' general competencies, and each general competency is composed of four specific competencies where one of them corresponds to a level of performance that can be: beginner, intermediate, advanced or mastery. Moreover, learner competencies are defined relative to a training domain. Each specific competence is developed by associating a composition of activities performed by a group of actors in a learning environment. Each competency is defined by skill selected from predefined skill taxonomy. Furthermore, according to Paquette (2002)" for any generic skill, it is possible to add performance indicators such as frequency, scope, autonomy, complexity and/or context of the use ". The usefulness of such indicators is to help build ways to assess the competency. We define for each level a set of prerequisites that can be:

Degree: University degrees or not.

Competencies needed: Describe the Knowledge and the skills needed. Furthermore, we check these competencies through a diagnostic test at the beginning of the training.

In order to propose the competency model, we have presented the tables (Tables 1, 2, 3 and 4) below that provide a view of all the elements and attributes of the proposed competency, while figure (Fig. 1) depicts the basic elements of the competency model.

The tables below contain the following information:

- The first column provides a reference to the competency model element.
- The second column specifies the name of the competency model element.
- The third column specifies the element's explanation.
- The fourth column specifies the requirement's element, under which the given element becomes mandatory (M) or optional (O).
- The fifth column specifies the multiplicity.
- The sixth column specifies the data element type that can be: identifier (ID), string (Str), Integer (Int) or sequence (Seq).

Table 1 Elements of competency domain and competency sub-domain

No	Name	Explanation	Reqd	Mult	Type
0	Domain	This element specifies of the domain of training	M	1	Seq
0.1	Identifier	A unique label that identifies this domain of training	M	1	ID
0.2	Title	A single text label for the domain of training	O	0.1	Str
0.3	Sub-domain	This element specifies of the sub-domain of learner competency	M	1	Seq
0.3.1	Identifier	A unique label that identifies this sub-domain of training.	M	1	Str
0.3.2	Title	A single text label for the sub-domain of training	O	0.1	Str
0.3.3	Description	A description of the sub-domain of training	O	0.1	Str
0.3.4	General competency	This element specifies the general competencies description of a sub domain	M	1..*	Seq

Table 2 Elements of a general competency description

No	Name	Explanation	Reqd	Mult	Type
0	General competency	This element specifies the general competencies description of a sub domain	M	1..*	Seq
0.1	Identifier	A unique label that identifies this general competency	M	1	ID
0.2	Title	A single text label for the general competency	O	0.1	Str
0.3	Definition	A structured definition of the general competency	O	0.1	Str
0.4	Specific competency	This element specifies the specific competencies description of a sub domain	M	1.4	Seq

We demonstrate in the Table 5 a real example by assigning certain values to each element of the proposed competency model, using the descriptive of the industrial engineering discipline of National School of Applied Science “ENSA Agadir”.

Table 3 Elements of a specific competency description

No	Name	Explanation	Reqd	Mult	Type
0	Specific competency	This element specifies the specific competencies description of a sub domain	M	1.4	Seq
0.1	Identifier	A unique label that identifies this specific competency	M	1	ID
0.2	Title	A single text label for the specific competency	O	0.1	Str
0.3	Definition	A structured definition of the specific competency	O	0.1	Str
0.4	Prerequisites	This element specifies the types of necessary prerequisites for access to a particular level of training.	O	0..*	Seq
0.4.1	Degree	A text label that identifies the university or non degrees that are required for a performance level	O	0..*	Str
0.4.2	Competencies needed	This element identifies the necessary competencies (skills and Knowledge) to mastering a proficiency level	O	0..*	Seq
0.4.2.1	Knowledge	A text label that identifies the necessary Knowledge to mastering a proficiency level	O	0..*	Str
0.4.2.2	Skills	A text label that identifies the necessary skills to mastering a proficiency level	O	0..*	Str
0.5	Description	This element specifies a complete description of the specific competency	M	1..*	Seq
0.5.1	Context	Refers the environment in which the activities are carried	O	0.1	Str
0.5.2	Performance Level	Refers to the performance level of the Competency	M	1	Seq
0.5.2.1	Level	A text label that identifies different types of performance level	M	1.4	Seq
0.5.2.1.1	Name	A text label that identifies different types of performance level	M	1.4	Str
0.5.2.1.2	Description	A description of the Performance Level	O	0.1	Str
0.5.2.2	Scale	The qualitative or quantitative scales of the Competency's level	O	0.1	Seq

Table 4 Elements of scale description

No	Name	Explanation	Reqd	Mult	Type
0	Scale	The qualitative or quantitative scales of the Competency's level	O	0.1	Seq
0.1	Quantitative Scales	The quantitative scales of the Competency's level	O	0.1	Seq
0.2	Minvalue	The minimum value of the quantitative scale	O	0.1	Int
0.2.1	Maxvalue	The maximum value of the quantitative scale	O	0.1	Int
0.2.2	Threshold	the value of success threshold of a competency	O	0.1	Int
0.3	Qualitative Scales	The qualitative scales of the Competency's level	O	0.1	Seq
0.3.1	Min category	The minimum category of the qualitative scale	O	0.1	Str
0.3.2	Max category	The maximum category of the qualitative scale	O	0.1	Str
0.3.3	Threshold	the category of success threshold of a competency	O	0.1	Str

In the same way, we define other competencies specifics that are:

- Level name: intermediate.

The learner must be able to apply structured methods (SADT, SART ...).

- Level name: advanced.

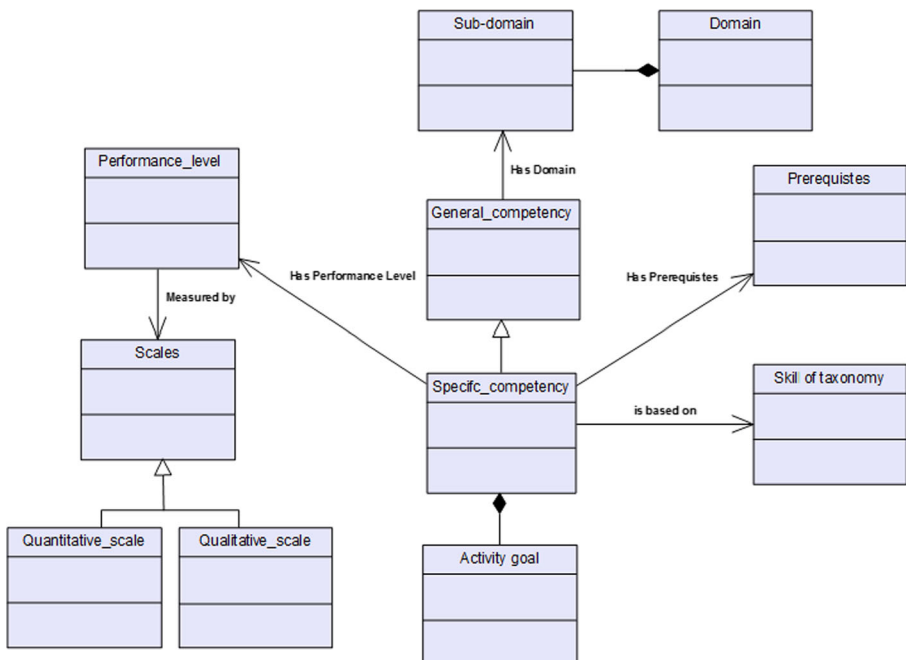


Fig. 1 Basic competency elements

Table 5 Example of a general competency description

Domain	
Identifier	ENG
Title	Engineering
Sub-domain	
Identifier	GIE
Title	Industrial Engineering
Description	Industrial engineering is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skill in the technical, economical, and social fields.
General Competency	
Identifier	GIEM1GC1
Title	Mastering Analysis and design of databases
Definition	The learner must be able to master the techniques, tools and basic methods of Analysis and Design of Information Systems (ACSI), and secondly, Data Base Management Systems (DBMS) via SQL language.
Specific competency	
Identifier	GIEM1GC1CS1
Title	Basic concept
Definition	the learner must be able to know the role of information systems in an organization and the different levels of abstraction (conceptual, organizational, operational)
Prerequisites	
Competencies needed	
Knowledge	Basic knowledge of programming and office (preparatory cycle).
Skills	Basic skills of programming and office (preparatory cycle).
Description	
Context	1st year of Industrial Engineering cycle to National School of Applied Science (ENSA Agadir)
Performance Level	
Level	
Name	Beginner
Description	This level could be made in the majority of cases, with partial scope, with little assistance and in familiar cases.
Scale	
Quantitative Scales	
Minvalue	1
Maxvalue	20
Threshold	12

The learner must be able to apply the tools of the method MERISE.

- Level name: Mastery.

The learner must be able to master the techniques and tools of Data Base Management Systems (S.G.B.D.) via the SQL language.

We focus on how to represent competency model as a rich data structure. The domain, sub-domain of training and prerequisites are the new elements that characterize the competencies compared to existing standards. In addition, the improved competency model involves the context, the proficiency Level (skills and knowledge) and the performance level.

5 Conclusion and future work

In this paper, we have treated the competency term, based on the main competency definitions. In addition to this, we have looked at the specifications for competency modelling, like the IMS RDCEO and the HR-XML specification. Furthermore, we have proposed a definition of the competency term and an improved competency model.

Like Pernin (2003), to structure a training module we adopt three levels of educational objectives of learning objects (learning units, activities and resources). Therefore, future work will include the design and implementation of a competence ontology based on this model. In addition, we will suggest a model describing learning activities and resources. Additionally, our model is a starting point for enhancements and testing.

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