Competence Based Educational Metadata for Supporting Lifelong Competence Development Programmes

Demetrios Sampson and Demetrios Fytros

Department of Technology Education and Digital Systems, University of Piraeus, Greece

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Advanced e-Services for the Knowledge Society Research Unit, Informatics and Telematics Institute, Centre for Research and Technology Hellas, Greece

e-mail:{sampson, dfytros}@iti.gr

Abstract

In the context of the emerging paradigm of Lifelong Learning, competence-based learning is gradually attracting the attention of the Technology-Enhanced Learning community, since it appears to meet the training expectations of both individuals and organisations. On the other hand, the paradigm of Learning Objects retains, to a large extent, its initial anticipations and, supported by Educational Metadata, it is still influencing Technology-Enhanced Learning system design. Nevertheless, the IEEE LOM Specification does not directly support the description of learning resources in terms of their relevance to competence-based learning programmes. In this paper we target addressing this problem, that is, we identify and study the main issues related to the competence-relevant characteristics of learning resources and propose an IEEE LOM Competence Application Profile that can be used for tagging educational resources in a competence-meaningful manner.

1. Introduction

In the context of the emerging paradigm of Lifelong Learning, competence-based learning is gradually attracting the attention of the Technology-Enhanced Learning community, since it provides important benefits for both individuals and organisations. At the individual's level, a competence-based learning approach may help in identifying and targeting competences that need to be developed in order for an individual to reach the competences defined by a career or by an organization. At the organizations' level, competence-based learning bares the potential for designing competence development programmes that targets to performance improvement and enhances human resource potential [1].

A typical Competence Development Lifecycle consists of the following key steps and aims at the continuous enhancement and development of individual and/or organizational competences: (a) the creation of a competence model, (b) the assessment of existing competences, (c) the gap analysis between existing competences and the required competences for a specific job role, (d) the definition of Competence Development Programmes to minimize the identified gaps and (e) the continuous performance monitoring and assessment to confirm improvement [2].

Competence Development Programmes refers not only to formal learning activities that lead to certificates or degrees, but also to informal learning activities which facilitate competences' acquisition by practice rather than intentional learning [3]. As learning activities are considered the designed or performed activities that are directed at the attainment of an explicit or implicit learning objective [4] and they consist of small pieces of educational material (referred to as learning objects) that feed directly the Competence Development Programmes and indirectly the Competence Development Lifecycle.

Learning objects can be described with IEEE Learning Object Metadata (LOM) [5], that is, a metadata standard for the description of educational resources. Nevertheless, the current version of the IEEE LOM does not support the description of learning resources in terms of their relevance to competence-based learning programmes. Previous related work deals with the adaptation of IEEE LOM in order to support the description of competence related characteristics of learning resources [6, 7]. However, their proposals do not take into consideration the specifications for competence

description proposed by international working groups such as IMS, IEEE and HR-XML.

In this paper we target addressing this problem, that is, to identify and study the main issues related to the competence-relevant characteristics of learning resources and propose an IEEE LOM Competence Application Profile that can be used for tagging educational resources in a competence-meaningful manner.

The paper is organized as follows. Following this introduction, Section 2 presents the concept of competence, identifies the key dimensions of competence, and studies the current initiatives on standardization of modeling competencies. Section 3 describes the proposed approach for defining an application profile of the IEEE LOM standard [5]. In Section 4, we present the proposed competence-based application profile of IEEE LOM standard produced as a result of the above described process. Finally, we discuss our findings and the conclusions that can be offered.

2. Theoretical background

Today, competences are proved to be a critical tool in human resource management, vocational training and performance management. 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 [8, 9, 10]. Furthermore, there is a certain confusion and debate 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 competency in the American sense complements competence as used in the UK occupational standard. However it is evident that competencies are only a subset of the required competences for a given professional and/or academic field [11]. In this paper, competency will be used as a synonym of the term "skill", while competence is 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 [10]. Performance may range from the basic level of proficiency to the highest levels of excellence. Figure 1 presents a schematic representation of the key dimensions of the term competence identified from the above definition.

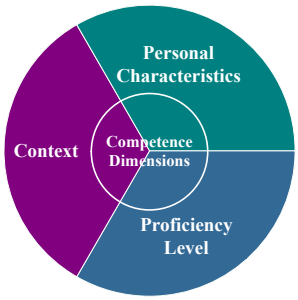

Figure 1. Competence dimensions

Competencies can be formally modeled and interchanged using the existing data models for competencies description. To this end, Specifications for competence description, such as the IMS RDCEO (Reusable Definition of Competency or Educational Objective) [12], the IEEE RCD (Reusable Competency Definitions) [13] and the HR-XML Competencies (Measurable Characteristics) [14] have been recently proposed.

Mapping the elements of IMS RDCEO to those of the HR-XML specifications indicates that both specifications provide: (a) identification of the competency, (b) title of the competency, (c) description of the competency, (d) definition of the competency, (e) taxonomy of the competency, (f) personal information, while HR-XML adds elements for measurable evidence and measurable weights and importance levels [15].

A careful examination of these specifications reveals that they do not included in their scope important dimensions of the generic competence model presented in Figure 1. Based on the key dimensions of competence, we have identified the following issues [15]:

a) The notion of competency itself is not detailed. However, competence modeling would anticipate including all the facets of the dimension "personal characteristics", namely knowledge, skills, and attitudes. So at least one further level of detail could be useful in the existing schemas for describing competences.
b) Measurement scales that represent proficiency levels can be both qualitative and quantitative. Although expecting to use a single, unified measurement scale is not realistic, it would be desirable that at least the values of these scales must be represented in an ordered list, as part of the competence definition schema.
c) The existing approaches to modeling competencies exclude context from their schemas. However, the context is an important dimension related to

competence it should be included in the competence description.

At this point, it should be noted that these issues cannot be considered as a list of flaws for HR-XML or IMS RDCEO, since these specifications clearly declare that these areas are outside of their scope.

3. Methodology

Although a generally accepted standard for the description of learning objects already exists, namely the IEEE LOM, it lacks on competence related information of educational reseources. Thus, in order to identify the competence related characteristics of learning objects, the integration of learning object metadata with competence related metadata is needed. The output of this process is an IEEE LOM Competence Application Profile.

Hence, based on the key dimensions of competence and the formally defined competency specification models and with regard to the CEN guidelines for building application profiles in e-learning [16], we can identify information resources that can indicate possible extensions to the IEEE LOM standard concerning competence properties.

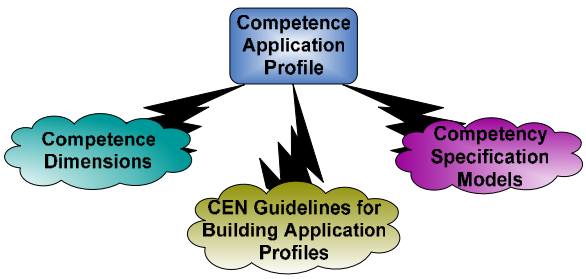

Figure 2. Specification and guidelines that can indicate possible extensions to IEEE LOM standard

The process of deriving competence metadata from the identified guideline categories consists of the following key steps:

Step 1: Identifying the concept of competence. The first step aims at the exploration of the competence concept in an effort to get a complete understanding of the different dimensions that this term incorporates. The output of this step is detailed in [10].

Step 2: Studying existing competence specification models. This step aims at the understanding of the models that international working groups such as IMS and HR-XML build for describing competencies. The output of this step is the mapping between the elements of these two models and the identification of aspects that are important for competence modeling, based on the competence dimensions.

Step 3: Identifying the competence relevant characteristics of learning resources. At this step, based on the key dimensions of competence and the existing initiatives on building specifications for competencies description, we create a schematic representation of competence relevant characteristics for learning resources that will be the guide in our effort to identify possible extensions to the IEEE LOM standard concerning competence related information.

Step 4: Identifying the competence related IEEE LOM elements. This step aims at the identification of the competence related IEEE LOM elements. To this end we examine all the categories and elements of IEEE LOM, in order to find available "items" that will host the competence relevant characteristics of learning resources.

Step 5: Extending value space or datatype. This step includes the identification of possible extensions required in the value space or datatype of the competence related IEEE LOM elements. This process extends when necessary the value space or datatype that the related element uses.

Step 6: Adding new sub-elements to the related LOM element. During this step new elements are added if necessary to the information model, with special attention for avoiding semantic overlaps with other existing elements of the information model.

4. IEEE LOM competence application profile

In this section, we propose an IEEE LOM Competence Application Profile that can be used for tagging educational resources in a competence-meaningful manner. To this end, a schematic representation of competence relevant characteristics of learning resources is created to guide our efforts in identifying possible extensions to the IEEE LOM standard on competence related information. More specifically, the main elements of the schematic representation are as follows:

- **Title:** A short name for the competence that the learning object targets.
- **Description:** A narrative description of the competence that the learning object targets.
- **ProficiencyLevel:** The proficiency level of the competence that the learning object targets. The proficiency level may include a short name and a narrative description. It may also include different types of proficiency level based on the facets of the dimension "personal characteristics" of the term competence, such as "Knowledge", "Skill" and "Attitude". Moreover different scales may be

used in order to represent proficiency levels. The values of these scales must be represented as an ordered list.

- **Context:** The context in which the competence that the learning object targets is referred.

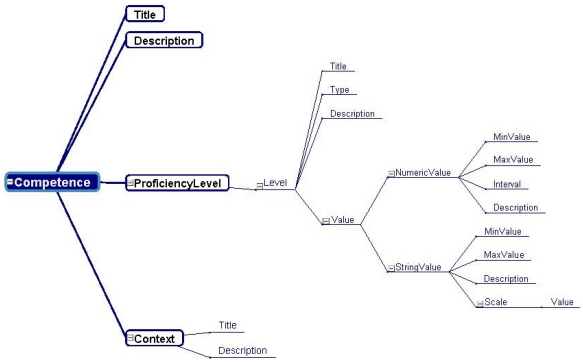

Figure 3. Competence relevant characteristics of learning resources

The next step is the identification of the most competence related IEEE LOM elements, based on the above schema (Figure 3). More specifically the IEEE LOM categories that we identified to be related with competence properties of learning resources are the **Educational** Category via the **Difficulty** element and the **Classification** Category via the **Purpose** element.

The introduced extensions to the IEEE LOM information model are presented in a tabular form for each identified IEEE LOM category presented in Figure 4. More specifically:

The IEEE LOM Classification category describes a learning object in relation to a particular classification system [5]. In sub-element Purpose (Nr 9.1) we can use the "competence" value to state that the purpose of the classification is defining the competence that is the intended outcome of the learning object. This element contains a specific vocabulary (prerequisite, accessibility, etc.) that must be updated with the "competence" value (Table 1).

Table 1: Extensions of IEEE LOM classification.purpose element

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
9	Classification	This category describes where this learning object falls within a particular classification system	smallest permitted maximum: 40 items	Unordered			
9.1	Purpose	The purpose of classifying this learning object		Unspecified	accessibility prerequisite ... competence	Vocabulary (State)	Example: "competence"

The IEEE LOM Educational.Difficulty element (Nr 5.8), describes how difficult it is to work with or through this learning object [5]. This element can be used for the representation of the competence proficiency level that this learning object addresses. However, extensions to this element are needed in order to include sub-elements, such as the proficiency level scale (Table 2).

Table 2: Extensions of IEEE LOM educational.difficulty element

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
5.8	Difficulty	The competence proficiency level that this learning object addresses	1	Unspecified			
5.8.1	Level	There may be multiple instances of this category	3	Unspecified			
5.8.1.1	Title	Text label of the proficiency level	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "Novice"
5.8.1.2	Type	The type of the proficiency level	1	Unspecified	Knowledge Skill Attitude	Vocabulary (Enumerated)	Example: "Skill"
5.8.1.3	Description	A human-readable description of the proficiency level	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "Adequately performing of the targeted competence"
5.8.1.4	Value	Rating values for this competence proficiency level	1	Unspecified			
5.8.1.4.1	NumericValue	NumericValue is the location for quantitative rating scales	1	Unspecified			
5.8.1.4.1.1	MinValue	The minimum value of the rating scale	1	Unspecified		Double (in the range 1 to 100)	Example: "1"
5.8.1.4.1.2	MaxValue	The maximum value of the rating scale	1	Unspecified		Double (in the range 1 to 100)	Example: "10"
5.8.1.4.1.3	Interval	The increment or step for the relevant scale	1	Unspecified		Double (in the range 1 to 100)	Example: "1"
5.8.1.4.1.4	Description	A human-readable description of the rating scale	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "A ten level scale for english language competence"
5.8.1.4.2	StringValue	StringValue is the location for qualitative rating scales	1	Unspecified			
5.8.1.4.2.1	MinValue	The minimum value of the rating scale	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "A1"
5.8.1.4.2.2	MaxValue	The maximum value of the rating scale	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "C2"
5.8.1.4.2.3	Description	A human-readable description of the rating scale	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "A six level scale for spanish language competence according Europass"
5.8.1.4.2.4	Scale	The scale that is used in order to represent proficiency levels	1	Unspecified			
5.8.1.4.2.4.1	Value	An ordered list with the values of the scale	n	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "Novice", "Advanced", "Proficient"

Finally we introduce the addition of a new category with special attention for avoiding semantic overlaps with other existing elements of the information model, namely Competence category that consists of three main elements namely title element, description element and context element (Table 3).

Table 3: Extensions of IEEE LOM - competence category

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
10	Competence	This category specifies the competence description	1	Unspecified			
10.1	Title	Text label of the competence that the learning object targets	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "Problem Solving"
10.2	Description	A human-readable description of the competence that the learning object targets	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "Identifying problems and implement solutions"
10.3	Context	The context in which the competence that the learning object addresses is applied	1	Unspecified			
10.3.1	Title	Text label of the context	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: "Kick-off Meeting"
10.3.2	Description	A human-readable description of the context	1	Unspecified		LangString (smallest permitted maximum: 1000 char)	Example: " The first meeting with the project team to discuss the role of each team member"

5. Conclusions

In the context of the emerging paradigm of Lifelong Learning, competence-based learning is gradually attracting the attention of the Technology-Enhanced Learning community. This increasing interest has resulted in international efforts to foster portability and sharing of competence related information across vendors, platforms and systems. On the other hand, repositories of Learning Objects tagged with educational metadata are still expected to deliver benefits to the TeL community. However, the IEEE LOM Specification does not directly support the description of learning resources in terms of their relevance to competence-based learning programmes.

In this paper it was argued that it is reasonable to attempts synchronizing these two major trends. To this end, we claim that an IEEE LOM Competence Application Profile is needed for tagging educational resources in a competence-meaningful manner for facilitating people and organisations in their search, retrieve, (re)-use and share of appropriate learning resources for Competence Development Programmes. Thus, following the CEN guidelines for building application profiles, we presented our proposal for an IEEE LOM Competence Application Profile, based on the competence dimensions identified in our previous work [10] and the existing competency specification models (IMS RDCEO, HR-XML).

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