Modelling Specifications for Competence

Elena Dikova Shoikova

Abstract - **Modelling competences is an integral part of many e-Learning and Human Resource (HR) related activities. HR departments use competence descriptions to define requirements needed for performing specific tasks or jobs. In distributed e-learning curricula or training programmes need to describe prerequisites that must be fulfilled before joining and the competences that will be acquired after successful completion. This paper provides an overview of existing modelling specifications and describes our modelling approach for competencies, the structure of the Competency Catalogue and gives examples on how a competency can be modelled. Finally, section 5 concludes this paper with a summary and an outlook on future work**

Keywords – **competence, competency, model, lifelong learning, networks, community, distributed e-Learning**

I. INTRODUCTION

Nowadays, people mobility has increased. Learners may study abroad with the benefits of improving their competences, receiving a better certification, or specializing in a topic not available in their regions. For learning organizations, requirements to join the programme must be taken into account. For example, an applicant needs to possess a Bachelor degree to apply for Master studies; in order to attend an expert course on a topic, a certification on a basic level may be required. Furthermore, assuming that an applicant fulfils such requirements, exemptions could be granted for parts of the programme that are similar to earlier followed courses. Currently, all these competence matches have to be performed manually, with hardly any guidelines or support. One important reason for this is that there are currently no sufficiently expressive common formats for the representation of competences, which is needed for complex competence profiles and requirements. Some initiatives, such as the IEEE Reusable Competency Definition (IEEE RCD, 2005) and HR-XML (HR-XML, 2004), have done initial steps to define common models and schemas for interoperability, but their current work lacks some important information that is required for competence matching, like proficiency levels, context or mechanisms for increasing reusability.

In [10], the authors suggest that the universities, professions, employers and the community have much to gain from the activities concerned with the development of competency based standards, although they do not believe that a full-blown competency based approach to education will become dominant in university courses.

Competency based education is a systematic yet flexible approach to organizing instruction. This approach focuses on defining in measurable terms what students are to learn and then evaluating how well they can perform designated tasks after instruction. Expected behaviours or tasks, conditions for their performance, and acceptable standards are shared with students prior to instruction. Competencies are based on performance of tasks identified by workers in the given occupation. CBE is an institutional process that moves education from focusing on what academics believe graduates need to know (teacher-focused) to what students need to know and be able to do in varying and complex situations (student and/or workplace focused).

CBE is focused on outcomes (competencies) that are linked to workforce needs, as defined by employers and the profession. CBE's outcomes are increasingly complex in nature, rather than deriving from the addition of multiple low level objectives. CBE often necessitates more complex assessment, involving portfolios, experiential learning assessment in field experience, demonstration in varying contexts, role play, etc.

Large skill sets are broken down into competencies, which may have sequential levels of mastery. Competencies reinforce one another from basic to advance as learning progresses; the impact of increasing competencies is synergistic, and the whole is greater than the sum of the parts. Competencies within different contexts may require different bundles of skills, knowledge and attitudes. The challenge is to determine which competencies can be bundled together to provide the optimal grouping for performing tasks. Another challenge is designing learning experiences that support students as they practice using and applying these competencies in different contexts. Continual refinement of defined competencies is necessary so that enhanced performance in a variety of contexts can be assessed. In essence, CBE is a process, not a product. In developing competency based standards, one of the benefits for the professions is that they are better able to understand and articulate their professions. Most professional organisations have used the processes of standards development to improve dialogue and relations between themselves and the universities with regard to curricula. Note, that one danger is the possibility of bureaucratically inspired external interference in the planning and conduct of professional education. University education is a complex process in which conceptual understanding and practical experience combine, and narrow perspectives may jeopardise the process. The development of competency based standards is therefore best left to the professions and the universities themselves.

This paper is organized as follows: section 2 clarifies the terms used throughout the paper and briefly introduces our requirements for modelling competences. Section 3 describes our modelling approach for competencies, the structure of the Competency Catalogue and gives examples on how a competency can be modelled. Section 4 provides an overview of existing modelling specifications. Finally, section 5 concludes this paper with a summary and an outlook on future work.

Elena Shoikova, DSc, MSc, Eng. is with the Department of Electronics and Electronics Technologies, Faculty of Electronic Engineering and Technologies, Technical University - Sofia, 8 Kliment Ohridski blvd., 1000 Sofia, Bulgaria, e-mail: shoikova@tu-sofia.bg

II. WHAT IS A COMPETENCE?

In this paper we adopt the TENCompetence definition of *competence* as "the estimated ability of an actor to deal with critical events, problems or tasks that can occur in a certain situation (at work, at home, etc.)". TEN-Competence [19] supports individuals, groups and organizations in Europe in lifelong competence development by establishing the most appropriate technical and organizational infrastructure, using open-source, standards-based, sustainable and innovative technology.

There exists some distinction between the two terms, *competence and competency* in the literature. IEEE RCD, 2005 [3] and IMS RDCEO, 2002 [2] define the stricter term of *competency* as "any form of knowledge, skill, attitude, ability, or learning objective that can be described in a context of learning, education or training". This definition is insufficiently expressive for competence gap analysis and designing competence based education. For example, it is not clear if the competency "English writing skills" represents a specific level such as intermediate, fluent, native or simply the existence of the competency. In fact, if that information becomes part of the competency definition, its reusability is drastically reduced. The current specifications to modelling competencies do not explicitly address the competence (plural: competences) as a three-dimensional variable, made up of a competency (plural: competencies), a proficiency level and a context (Figure 1).
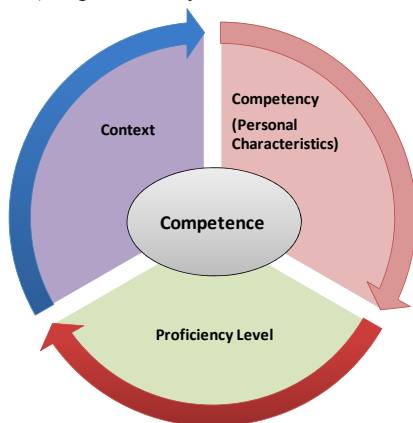

Figure 1 The Competence as a Three-dimensional Variable

For sake of clarity, and in order to avoid confusion between the terms competence and competency, we may use competency and personal characteristics interchangeably hereafter. There are four types of underlying characteristics defined for competencies:

- Knowledge – Information a person has in specific content areas.
- Skill – the aptitude to perform a certain physical or mental task.
- Ability – The innate physical or mental capacity of an individual to perform a task. The mental or cognitive abilities include analytical thinking (processing knowledge and data, determining cause and effect, organizing data and plans) and conceptual thinking (recognizing patterns in complex data).
- Behaviours - The actions or reactions of a person in response to internal or external stimuli

Knowledge, skill and ability competencies are visible and relatively surface level characteristics of people. Behaviours are more hidden, deeper and more central to a person's personality. Competence models in sense as models of interrelated competencies already play an important role in today's educational systems. In university/school curricula, competences build the basic structure to connect the different levels and curricula as well as their content. In organizations, competence-based assessments build the basis for controlling and steering services in the human resources departments, like staffing, career planning, and personalized training.

III. ONTOLOGY-BASED COMPETENCY CATALOGUE

Competency oriented approaches are gaining ground in education, training and human resource development. Key technology to cope with the complexity of fine-grained approaches is ontology. By having a formal semantics, many competency related tasks can be partially automated on a technical level. Through extensive literature search and review of best practices [15, 16, 17] a library of competencies has developed that have been shown to be critical to organizational success. In this paper, we present an ontology based competency catalogue (Figure 2) that provides a shared vocabulary. It can be used to model a competence profile — that is, a process that aims to identify the skills, knowledge, abilities, attitudes and judgement or the estimated ability of an actor to deal with critical events, problems or tasks that can occur in a certain situation. The ontology based competency catalogue comprises definitions and observable behaviours (Figure 3) and can be used as a very solid tool for making competency profiling.
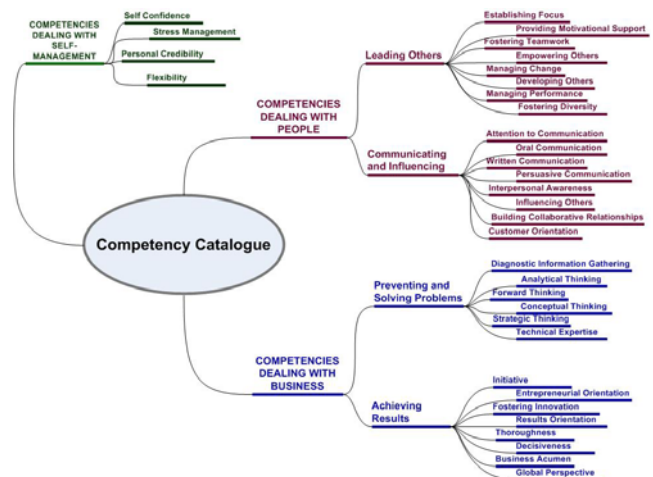

Figure 2 Ontology-Based Competency Catalogue

IV. RELATED WORK

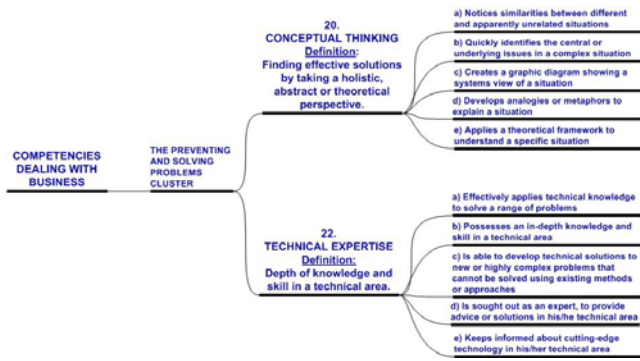*A. Competency Data Standards & Specifications*

Figure 3 Examples: Competency Definition and Observable Behaviours

These are technical standards about capturing, exchanging and managing data about competency, or technical standards about capturing and representing the competency models defined in a "competency standard".

The IMS Reusable Definition of Competencies or Educational Objective [2] and the later IEEE Reusable Competency Definition [3] focus on reusable competency definitions. Reusable Competency Definitions (RCD), as defined in IEEE P1484.20.x, may used to capture a competency definition at any level of specificity, from the most precise to the most general. The more specific a RCD is the less reusable it is. Often a less precise definition is very useful, especially when trying to compare competency data between different communities of practice. The primary idea is to build central repositories which define competencies for certain communities.

These definitions can be referenced by external data structures, encouraging interoperability and reusability. However, IEEE RCD lacks information on context and proficiency level and does not allow relationships or recursive dependencies among competencies. HR-XML [4] focuses on the modelling of a wide range of information related to human resource tasks (like contact data or aspects of the curriculum vitae). The work performed in HR-XML Measurable Competencies tries to define profiles in order to use such competency definitions. It specifies data sets like job requirement profiles (which describe the competencies that a person is required to have) or personal competency profiles (which describe the competencies a person has). Such profiles are composed of evidences (either required or acquired) referring to competency definitions (Figure 4).

Figure 4 Competence Data Framework

Competency data may include:
- Reusable (generic) definition of the competency
- Evidence of competency
- Context within which the competency is defined, or that defines the competency

- Dimensions such as proficiency on a scale, or time.

A *competency map* is a map of RCDs. It is a structure collection of nodes that reference RCDs. A competency map can be used to represent the relationships between competency definitions in:
- a job competency profile (requirements for the job)
- a personal competency profile (acquired competencies)
- a personal competency gap profile (competencies to learn).
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B. Competency Related Proposals and White Papers.

Ecosystem of competency management

The diagram presented on Figure 5 is an attempt to show how learning management, learning/training management and performance support systems can be aligned with business goals as part of an "ecosystem of competencies".
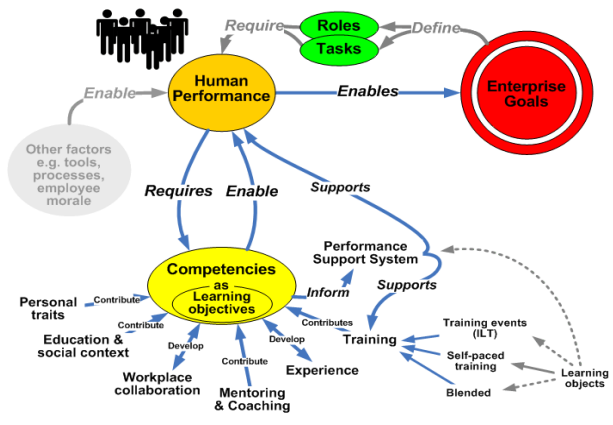
Figure 5 Ecosystem of Competency Management

Competency Data for Training Automation

In [13] the author proposes a simplified framework that uses simple, standard data formats and services to help automate the collection and adaptive assessment of individual and group competencies.

The framework also supports the automation of skill gap analysis as well as the automation of adaptive performance support. It also provides for auditing, general security, confidentiality and privacy requirements. It takes into account credibility issues and the sanity measures necessary to avoid corruption by unreliable data.

SCORM, Repositories and Competencies

Figure 6 illustrates a framework to support functional requirements for competency tracking and personalized assessment, learning and training. The framework includes legacy data, processes and policies as well as new digital objects and systems. It also leverages standards like SCORM, digital object identifiers, the standards for repositories, and the CORDRA specification for the registration and resolution of identifiers for content objects.

The black arrows and the grey zones in the Figure 6 represent a general flow of data and processes that inform the competency modelling and the development of assessment and training resources. Those flows and processes are not amenable to standardization, because every organisation or agency has its own culture, priorities and processes that govern them. The coloured arrows represent interfaces between different services that implement the assessments, training and competency data management. These services may be part of the same system, or implemented as separate, cooperating systems in a Service Oriented Architecture (SOA). The arrows also represent "choke points" through which data travels from one service to another. The choke points allow a straight - forward enforcement of security, privacy, data filtering and data processing policies (e.g. confidential topics, HIPAA conformance, etc.).
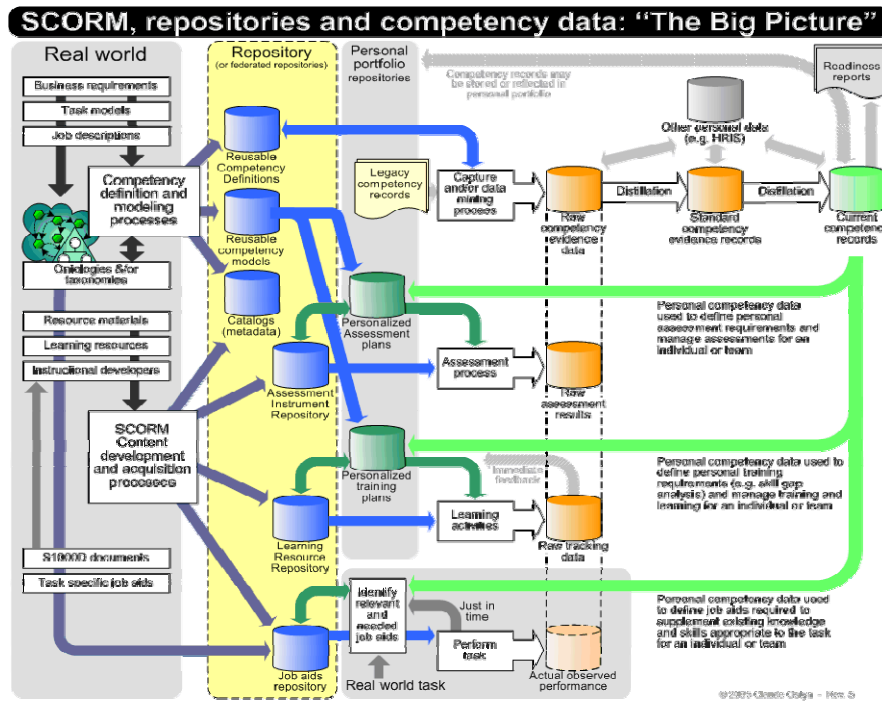

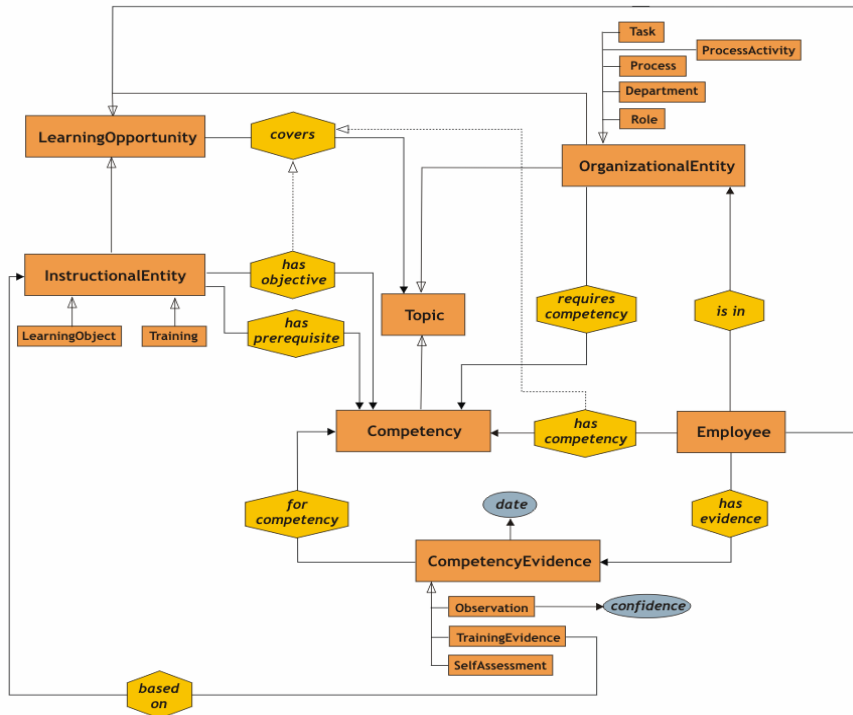*Figure 6 An Integrated Competency Management, Assessment and Learning Framework*

Figure 7 Top-Level overview of Professional Learning Ontology

The same framework also support readiness assessments based on competency records, personal portfolios, and Just In Time job aids and other performance support resources tailored to the requirements of any task. The lightly patterned gray arrows with grey caption represent shortcuts. One kind of shortcut shows how tracking data from learning activities can be used as immediate feedback to influence an automated adaptive learning plan. For example, in SCORM 2004 sequencing, the status of objectives can influence the adaptive sequence. Another kind of shortcut is the possible use of personal portfolios or portable personal profiles to store competency records. For example, an ePortfolio for a person might contain a personal learning plan (desired learning outcomes and a specification of the activities to each those outcomes), work products and competency records.

On Figure 7 is presented a top-level overview of professional learning ontology [18]. One of the core concepts is the *LearningOpportunity* as an abstraction for human and non-human resources that can foster individual learning processes; this encompassed pedagogically prepared learning objects, presence trainings. Depending on the level of formality and pedagogical preparation, these learning opportunities can be associated with competencies: information artefacts like documents are connected via a weak "covers" with competencies whereas trainings and learning objects are designed to build competencies ("has-objective"). In order to connect competencies with the organizational environment, *OrganizationalEntities* are introduced that can have competency requirements. Such organizational entities can take the form of tasks, processes, departments, roles etc. Furthermore, this top-level ontology also takes into account that competency can only be indirectly deduced from observations and other forms of *CompetencyEvidence*. This conceptualization forms the basis for a holistic view on competency-orientation; it integrated the perspectives of training and human resource development, business processes and knowledge management – and it also covers both strategic and operational aspects. This is an important first step both on the human actor and the technical level.

V. CONCLUSION

Competence development is a hot topic in different research communities, and different motivations have been important to discuss the topic. In distributed e-learning, often an individual perspective is taken on competencies, skills, and knowledge of the individual. In the area of knowledge management organizational backgrounds, return on investment (ROI) analysis and controlling issues were the main motivation to discuss about organizational competence development and strategic competence management.

Competency driven approaches are facing fundamental challenges. The main challenges are the integration of different levels of knowledge resource, learning activities, competence development, and learning networks. Raising the awareness and enabling a lifelong learning perspective and the integration of formal programmes with social software, informal learning and community building in learning networks. A well-defined common understanding of each competency needs to be developed and enforced across various departments of the educational or training organization. On the technical level, various systems and services involved in distributed learning systems and knowledge management need to be semantically coherent so that competency driven approaches can live up to their holistic expectations. The crucial trade-off in competency modelling needs to be solved: the more accurate, realistic and fine-grained considered competencies are the more complex management and controlling tasks become.

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