Chapter I

Competencies and Organizational Learning: A Conceptual Framework

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Abstract

Organizational learning can be considered as systemic behaviour oriented to acquire capacities for dealing with the needs and challenges of organizations in competitive environments. This entails that there must be some measurable and flexible concept that drives the acquisition of those capacities. Competencies understood as the workplace capabilities of individuals or groups can be used as one of the approaches for managing such capacity-acquisition behaviour. Even though competency is not a new concept, the management of competencies through information technology (IT) for improved effectiveness and efficiency poses a number of significant challenges that still require much research to come up with general-purpose and reliable solutions in the information systems discipline. This chapter delineates the main concepts for a competency-based framework in the context of organizations and enumerates some requirements for which definitive and commonly accepted solutions are still not available.

Introduction and Background

Competencies as related to learning and work performance have received a great deal of attention in the last years. This has resulted in a plethora of papers and reports on how competencies should be defined or assessed, including some papers that deal with their representation in a computational form. But the literature on the topic is fragmentary in what concerns the concept of competency, since definitions are in many cases taken for granted, and, in other cases, the studies focus on a single aspect of competencies. This makes it difficult for newcomers to have a clear understanding on the main issues that need to be dealt with when approaching competency-based systems. That lack of a systematic way of dealing with competencies calls for a clear statement of the requirements that are significant for studies and future research on the topic.

This chapter attempts to provide a checklist, or roadmap, for such requirements. To do so, we will start with a concrete definition for the term competency, and then we will proceed to describe the main requirements in a synthetic way, hoping that the resulting collection of aspects is valuable as a skeleton for the clarification and comparison of the concrete approach each author or system is providing in what regards to competencies.

The notion of competency is linked to the concept of human performance, which according to the model of Rummel (Rothwell & Kazanas, 1992) encompasses several elements: (a) the work situation is the origin of the requirement for action that puts the competency into play, (b) the individual's required attributes (knowledge, skills, attitudes) in order to be able to act in the work situation, (c) the response, which is the action itself, and (d) the consequences or outcomes, which are the results of the action and which determine if the standard performance has been met. Finally, individuals usually receive some kind of feedback depending on the success or failure of their action.

Since competency is related to human capacity, it is clear that *learning* is a process that eventually results in improving competency. In straightforward terms, then, learning activities can be arranged, scheduled, carried out, and evaluated with the aim of helping employees to acquire some required competencies for concrete work situations. This link is a first important assumption in competency approaches to e-learning in organizational settings, which in turn leads to a first requirement for them.

> *Requirement #1*. Competency-based approaches to organizational learning require an explicit model for linking competency definitions to learning activity objectives.

Even though this first requirement may seem obvious, it entails a number of related requirements that are described in what follows and that do not have a straightforward solution. The first one is the formal definition of competencies, that is, the aspects of competencies that should be considered. Knowledge, skills, and attitudes are often mentioned as examples of such aspects or contributing elements. However, there is not a single definition accepted, and the approaches will be different depending on the granularity and level of detail considered. This leads to a second requirement.

Requirement #2. The components of competencies must be clearly described.

An ontological schema for the Rummel model cited above can be found in the work of Sicilia (2005). Further, relationships between competencies are an important element to be considered. A discussion of techniques for dealing with some typical competency relationships can be found in Sicilia, García, and Alcalde (2005).

In addition to describing competency components, a definition of the measurement instruments and scales is required. An option is an "all or nothing" approach, in which an individual has or not a given competency. However, it is more common to have some measurement scale, numerical in a range or qualitative, based on linguistic labels, as "high" or "low."

Requirement #3. The scales or constructs for measuring competencies must be defined.

Following with measurement issues, competencies in organizational approaches will likely be aggregated in constructs as "competencies of a team" or "competency level for the organization." These aggregations entail a concrete kind of "algebra" of competencies. For example, existing approaches differ in these aggregations to be compensatory or not (Sure, Maedche, & Staab, 2000).

Requirement #4. The aggregation techniques considered valid must be defined to the level of allowing a form of computing aggregated competency levels.

Competencies are, of course, the actual capabilities of employees, but the same concept can be used to express desires or needs, that is, competency requirements. When understood as a lack that should be fixed, one can use the term "competency gap." This raises an additional requirement.

Requirement #5. The expression of needs and objectives in terms of competencies must be specified in terms of the same model used to express the capabilities of individuals or groups.

In addition to the representational problems described so far, the procedures or techniques that are considered proper for the assessment of the presence of competencies in individuals require consideration. Such techniques may involve observation, tests, inter-subjective assessments, or any other technique that is considered reliable.

Requirement #6. The procedures for the assessment of competencies considered valid must be stated.

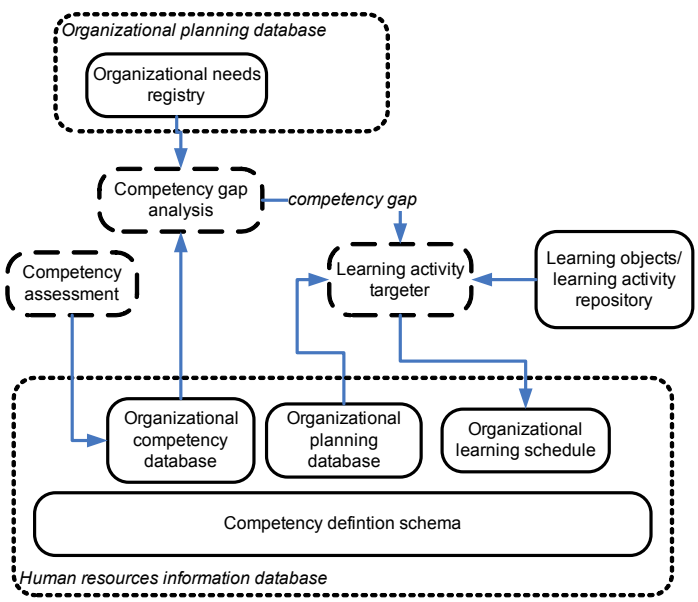
With the above requirements, the representation is equipped with the fundamental aspects. But more is required for an effective selection and targeting of learning activities to cover competency gaps. The first of these additional aspects is that of how to combine pedagogies with the competency-based selection of activities or learning resources. Different kinds of pedagogical accounts could be considered (Sicilia & Lytras, 2005), and these could better fit different settings. Another important element is how to combine the agendas and time constraints of employees with the targeting of learning activities. It is possible that the employees that are better prospects for the immediate acquisition of some competencies have, in fact, a workload that impedes it. These aspects illustrate the fact that algorithms that target learning activities to fill competency gaps in organizations are complex and require the consideration of diverse dimensions.

The following section briefly sketches the main elements of an information system approach to competency-based learning. Later, some specificities of such an approach for the current state of technology will be mentioned, with the aim of serving as a roadmap for research and practitioner work in the field.

Main Components of an IT-Based Approach to Competency Management

The above discussion provides a blueprint for competency management information systems. Since competency definitions are potentially complex, and the amount of information on

Figure 1. Main generic components for competency-based approaches



employees, teams, and business needs is large, an information technology-intensive solution becomes a critical issue. Figure 1 depicts the main functional, generic components of a competency-based approach to organizational learning.

Figure 1 includes functional components that store information, represented as rounded rectangles, and also a number of processes, namely "competency gap analysis," "competency assessment," and "learning activity targeter." The following is a concise description of the elements in the figure:

- The *competency definition schema* is the realization of requirements #1 and #2 above, and the *organizational competency database* is the registry of all the competencies that are believed to be possessed by the employees. This last component is basically a part of a human resources database in which the actual competencies of each employee are described in detail.
- The competency database is updated by the activity of *competency assessment*, which should at least be triggered after each scheduled learning event. According to requirements #3 and #6, this assessment requires pre-established, documented procedures to provide a degree of homogeneity that allows the aggregation of competencies.
- *The organizational planning database* contains the information of the calendar and activities of the whole organization, and the project plans with the information of the employees assigned to each of them.
- The *organizational learning schedule* (which could be considered a part of the planning database) contains the information of the learning activities scheduled, be they individual or team-based.
- It is supposed that some kind of *learning resources and/or learning activity repository* exists, storing contents, learning plans, and other resources for reuse in future activities. In some cases, these resources might be outsourced or required on demand.
- The *organizational needs registry* aims to store the needs or desired capabilities of the organization. These may be derived from the needs in the projects or customer demands, or could be strategic, medium, or long-term directions. To comply with requirement #5, these needs must be expressed in terms of desired competencies.

The process of *competency gap analysis* takes as inputs the organizational needs and the organizational competency database to assess the mismatch between the two. For this to be effectively accomplished, clear algorithms and computation techniques (requirement #4) must have been agreed upon. Without that previous agreement, measurement of organizational progress in terms of competencies will be seriously flawed.

The competency gap then becomes the key measurement element that is used for action in the organization. Following it, the decision process of targeting learning activities to the "right" employees at the "right" time requires a consideration of the competency gap, the available competencies, and the agendas of the people. The result of such a "targeting" process is that some learning activities with some concrete objectives will be scheduled and initiated through the e-learning platform available company wide.

The succinct description above serves as an abstract framework of the key organizational assets that are required for a competency approach to learning. It can be used as a reference framework for the comparison of concrete studies, tools, or techniques, and, of course, it is simply an abstraction of the complexities of the competency paradigm that are reflected in the requirements stated in the previous section. In what follows, some e-learning technologies providing important services for that framework are referenced.

Bridging Competencies and Modern E-Learning

Modern e-learning technology in the last years has been influenced by the paradigm of learning objects. The concept of learning object is at the centre of the new paradigm for instructional design of Web-based learning that emphasizes reuse as a quality characteristic of learning contents and activities. For example, Polsani (2003) includes reuse in his definition of learning object as "an independent and self-standing unit of learning content that is predisposed to reuse in multiple instructional contexts," and Wiley (2001) also mentions the term in his learning object definition "any digital resource that can be reused to support learning." A number of specifications and standards that describe or make use of the learning object concept have evolved in the last years. The basic metadata elements associated with learning objects have been described in the IEEE LOM standard (IEEE, 2002), which organizes its conceptual metadata schema in nine categories: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation and classification. Learning objects are considered as reusable elements that can be used as part of learning designs.

In the experience and view of the authors, there are two important directions in learning technologies that are especially relevant for the competency approach described above. These are activity-orientation and the use of Semantic Web technologies. These are sketched in what follows.

Activity Orientation in E-Learning

The IMS LD[1] provides a powerful language for the expression of learning designs targeted at the realization of activities. An activity is considered as a piece of interaction among a number of specified roles played by persons who produce a tangible outcome by using a concrete environment made up of learning objects and services (facilities available at runtime). Activities can be further decomposed in sub-activities, and they are aggregated into methods that specify the conditions for application of the learning design, along with the planned objectives that will eventually match the outcomes of the activities. Methods can be structured around concurrent plays, and these in turn can be structured in sequential acts, the latter allowing the specification of execution conditions. This schematic description of LD gives an idea of the flexibility the specification provides in describing activity-based learning programs.

These activities can be framed in the context of process-orientation. The processes in an organization are related to different goal, obstacles, actions, and prerequisites (GOAP). We will now describe the main elements of the GOAP approach to process modeling (Eriksson & Penker, 2000). To start with, relationships between goals as dependencies and associations are introduced. The dependency should be interpreted as stating that the fulfilment of the smaller (partial) goal contributes toward the fulfilment of the larger (dependent) goal. A goal that has been completely broken down into partial goals indicates that the goal will automatically be fulfilled if all of the partial goals are met.

In connection with describing the goals we also describe the obstacles that stand in their way. An obstacle is a problem that hinders the achievement of a goal. By analyzing the problem, new goals or partial goals are discovered that attempt to eliminate the problem. An obstacle is therefore always linked to a goal. Similar to a goal, an obstacle can also be broken down into partial obstacles. Obstacles are eliminated (overcome) by actions. An action plan can be formulated from the goal/obstacle model, where temporary obstacles are resolved as soon as possible, and the goals linked to the continuous obstacles are allocated to processes in the business.

Finally, for each process, prerequisites take the form of input resources or supporting resources. The outcomes of the process module are relevant to different stakeholders in the organization, and the connection of the outcomes of concrete activities with the input and support of others provides a way to explain the transition from the individual to the organizational behaviour.

Competencies in the GOAP framework can be used as a specific kind of goal with some added descriptions. In this view, relationships between competencies and their constituents can be considered prerequisites; for example, "it is required to have competency X prior to be able to have competency Y," or "competency Z requires some attitude A." Further, learning activities as expressed in IMS LD can be considered specific actions. Thus, process models as GOAP combined with more learning-specific languages as IMS LD provide a seamless platform for competency approaches, with the added benefit of having available free technology implementing the workflow and automation aspects of IMS LD units.

Semantic Web Technologies and Competencies

The Semantic Web vision described by Berners-Lee, Hendler, and Lassila (2001) represents an approach to enhancing the current World Wide Web with machine-understandable Semantics. The essential idea is that Web resources as identified by URIs can be described by metadata with the purpose of enabling automated processing. The precision of logics-based descriptions (Baader, Calvanese, Mcguinness, Nardi, & Patel-Schneider, 2003) when used for creating metadata would allow for the creation of tools that do not solely rely on natural language processing as current search tools, thus ideally removing the problems associated with ambiguity and implicitness in natural language.

There are two fundamental kinds of benefits of using ontology description languages to express learning object metadata (Sicilia & García, 2005). On the one hand, those languages provide richer knowledge representation formalisms for metadata descriptions than using plain text, extensible markup language (XML) bindings, or even RDF. Here the benefits

are the result of using description logics, instead of simply using structured data in XML format or using RDF, which is a less-expressive language than DAML+OIL or OWL. On the other hand, the use of ontologies may eventually produce synergies with the technological advances that are taking place under the overall label of "Semantic Web." The most prominent of such synergies may come from the availability of shared, consensual ontologies on many domains along with tools to develop systems that exploit them for diverse "intelligent" behaviors. Further, the activity-oriented approach can be used in conjunction with ontologies as described by Sicilia (2006).

Further, competencies can be specified also through ontologies as described in (Sicilia, 2005). Thus, ontologies of competency descriptions and learning object ontologies can be used together as a framework for the competency-based approach.

Conclusion

Competencies as a representation and measurement paradigm can be used as a structuring principle for the selection and targeting of learning activities. However, such an approach requires the consideration of a number of non-trivial requirements, including how competencies are described and assessed, and how they are aggregated and combined.

The competency approach for driving organizational learning can be expressed in a number of functional elements and processes that provide a framework for the analysis and comparison of the variety of techniques, representation schemas, and algorithms that can be devised. Such framework has been sketched in the paper.

Finally, the deployment of IT-intensive competency systems requires advanced support for the representation of competencies and learning activities. IMS LD and ontology languages as those used in the Semantic Web have been described as two key enabling elements in that direction.

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