

# Sustainable Competency-Oriented Human Resource Development with Ontology-Based Competency Catalogs

Andreas SCHMIDT<sup>1</sup>, Christine KUNZMANN<sup>2</sup>

<sup>1</sup>*FZI Research Center for Information Technologies,  
Haid-und-Neu-Str. 10-14, 76131 Karlsruhe, Germany*

*Tel: +49 721 9654-732, Fax: + 49 721 9654-733, Email: andreas.schmidt@fzi.de*

<sup>2</sup>*Kompetenzorientierte Personalentwicklung,*

*Ankerstr. 47, 75203 Königsbach-Stein, Germany*

*Tel: +49 7232 409 3309, Fax: +49 7232 316943, Email: contact@christine-kunzmann.de*

**Abstract:** Competency-oriented approaches are gaining ground in human resource development. Key technology to cope with the complexity of fine-grained approaches are ontologies. By having a formal semantics, many competency-related task can be partially automated on a technical level. In this paper, we want to show that ontology-based approaches also foster the sustainability of such approaches on an organizational level by providing connections between the operational and strategic level. We present a reference ontology and a reference process model which have been applied in a hospital case study.

## 1. Introduction

Competencies as abstractions of work-relevant human behaviour have emerged as a promising concept for making human skills, knowledge and abilities manageable and addressable in a wide range of application areas. From a management point of view, they provide a more adequate approximation of human performance factors than the notion of "knowledge" in traditional knowledge management approaches as they can represent a *set* of skills, knowledge, and abilities that belongs together and as competencies go beyond mere "knowing" towards work-relevant action. For the traditional training (and human resource development) community, competencies allow for operationalizing learning goals and outcomes and thus can serve as a control instrument. And competence management approach aim at connecting the individual and the organizational perspective via the competency abstraction.

Competency-driven approaches are facing fundamental challenges: (a) A well-defined common understanding of each competency needs to be developed and enforced across various departments or even organizations (for organization-independent competency frameworks). (b) On the technical level, various systems and services involved in HR, training, and knowledge management need to be semantically coherent so that competency-driven approaches can live up to their holistic expectations. (c) 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. This can only be achieved by

A promising solution to these challenges are ontology-based approaches (e.g., proposed by [4], [5]). By modeling competencies and competency catalogs with formal ontologies, automating competency-related tasks becomes possible, ranging from training planning and needs analysis, via team staffing up to succession planning. Typical ontology-enabled tasks

include profile matching, gap analysis and the selection of appropriate learning opportunities.

## 2. Objectives

So far, in these approaches ontologies have mainly been seen on a technical level (even when applied to the HR domain), but successful introduction in corporate practice requires more than just technologies (as a case study showed in [1]). We need to consider how these approaches fit into existing business processes, and we especially need to consider the prerequisites for sustainability – too many innovative instruments introduced in companies were just flash in the pan, once introduced, then hardly ever updated. This is true for traditional competence catalogs, but even more for ontology-based approaches to competencies as these are even more model-driven. So the key issue for sustainability is here how to keep the ontology with the competence catalog as its core up-to-date so that it actually reflects what is needed.

In our research, we wanted to elaborate a reference model for ontology-based approaches to competency-oriented human resource development. The reference process is supposed to be geared towards the two key issues: (1) how to connect strategic and operational HR processes with the help of the competency catalog as a mediating artefact (representing the common understanding, challenge a) and (2) how to ensure continuous updating. This reference model is divided into a conceptual part, providing key concepts and the basis for semantic coherence and automation (challenge b and c), and a reference process part.

## 3. Approach

In a previous study [1], we have discovered that although competency-oriented approaches have gained a lot of popularity during the last years, the landscape is rather scattered, and there are various perspectives unaligned next to one another. Especially, management-oriented approaches (competence management from a resource-oriented perspective) on the one side, and competency-based e-learning approaches for learning on demand (like [3]) on the other side do not exploit synergies. In order to enable such synergies, we have developed a reference ontology (the so-called Professional Learning Ontology, [2]), which has been released under a Creative Commons License.<sup>1</sup> This ontology (see fig. 1) provides a shared understanding of different stakeholders integrating previous ontologies developed within other research and industry projects.

One of the core concepts of this ontology 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, checklists and other documents as well as other people (for informal learning). 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

---

<sup>1</sup> <http://www.professional-learning.eu/>

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: While it is clear that different perspectives still operate at different levels of abstraction, it is important that all stakeholders are aware of different abstraction levels of the same competency (or related ones). That way, e.g., aggregating individual competencies into organizational competencies becomes feasible, and breaking down organizational competencies into individual learning goals is also much more traceable. And both directions can even be supported by technology.

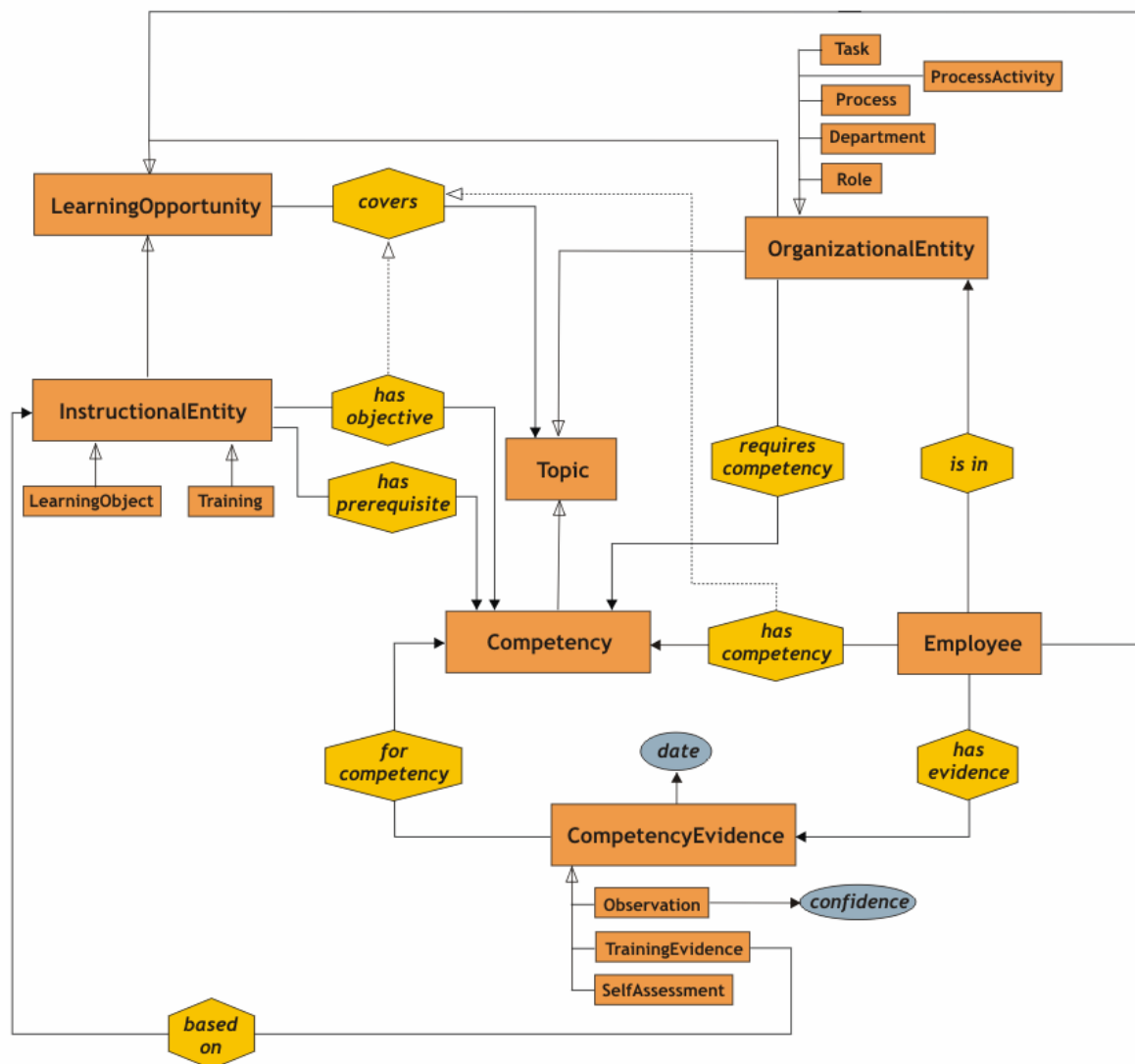


Figure 1: Professional Learning Ontology (Top-Level overview, see also [2])

The second building block of our approach is a reference process model that divides the responsibilities and tasks of competency-oriented human resource development according to the St. Gallen management model: normative layer, strategic layer, and operational layer.

Core of this process model is the strategic layer, which focuses on the instrument of a competence catalog (as a formal ontology), specifying the vocabulary for talking about requirements and employee competencies. Additionally, on this layer job requirements are specified, which are based on experiences with job performance, ideally measured in the context of quality management. The normative layer (responsibility of hospital management) mainly defines the goals (e.g., specialize in specific areas), which influence

the relevant competencies. On the operational layer, competencies of employees are diagnosed based on observable job performance using the competency catalog as a vocabulary. In a comparison with the requirements specified for the job role, the competency gap can be determined. Training measures are selected, which have these competencies as objectives. After the participation of the employee, the learning effects can be measured (in the form of assessments within the training activity) and afterwards the effects on job performance can be evaluated, which can lead to an augmented competency profile for the employee.

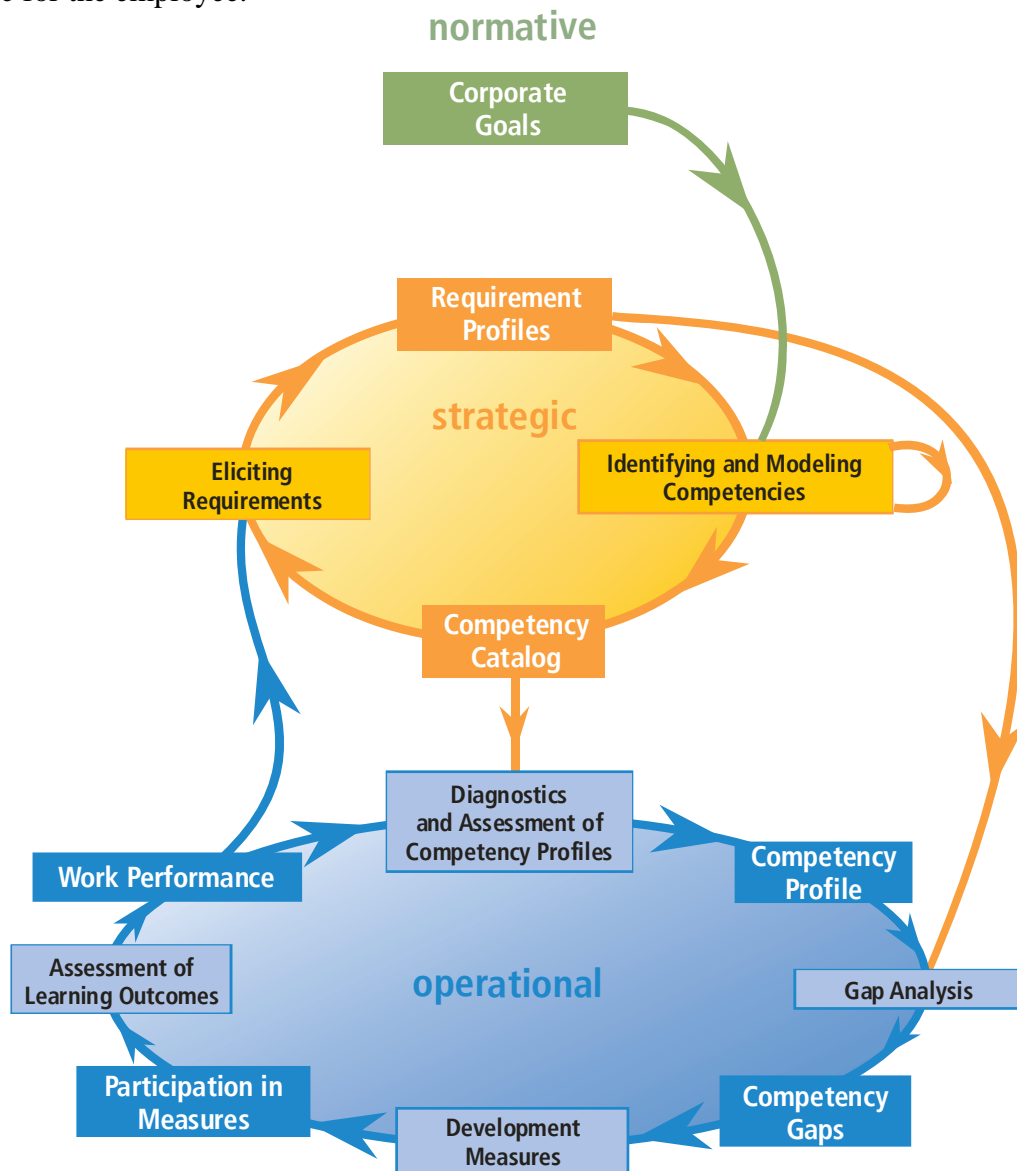


Figure 2: Layers of Competence Management (cp. [1])

This model is supposed to provide a reference for implementing it in companies. What is important is that it provides a closed loop, i.e., the changes in job performance are fed back into the competency definition and requirements profile creation process. The second important aspect is the mediating artefact of the competence ontology. By developing a shared understanding throughout the whole process, discussions are getting more productive and goal-oriented [1].

Both of these aspects promote sustainability, but still the effort needed to keep the competency catalog and associated requirement profiles remains considerable – although potentially distributed among various stakeholders. The key motivation for these

stakeholders to contribute to this process is usefulness: if it is useful for their work, then they are motivated to contribute. But how can this be ensured? There are two factors here: (1) models must be used for multiple purposes and (2) agility of the instruments and responsiveness to changes. The first factor is the very reason for ontology-based approaches (which will be explained in more detail in the next section). The second factor challenges traditional ontology engineering methods as they don't ensure timely reflection of changes in the environment within the ontology [6]. Here, we need to support the modelling processes with agile methods like the ontology maturing approach presented in [7]. The formalization in such approaches takes place gradually (e.g., starting with the definition of competencies, then placing them in a hierarchy, and adding relationships between competencies like relatedness, or composition) and different formality levels co-exists within the same ontology. These maturing approaches are also more suitable for embedding modelling activities into work processes.

#### **4. Technology**

Especially within the context of service-oriented architectures, which promise better integration and interoperation of business processes with IT services, such an ontology-driven approach can also help to structure the IT infrastructure landscape. On the one side, a shared conceptual model allows for interoperability of different systems. Competency models and topic hierarchies can be integrated conceptually so that their learning and training management systems can be integrated with knowledge management applications. Human resource development can be related with business processes via requirements and performances collected on the operational level so that changes in business processes are immediately reflected (and thus avoid inconsistencies).

On the other side, the ontology can also guide developments of new and more advanced services for learning support. One example are services for learning on demand, which we have developed with the EU project Learning in Process. For designing these services, we have applied a ontology-centered architectural style, which is illustrated in Fig 3. The service's responsibilities are derived from properties in the ontology: a service for a service for competency gap analysis computes the "needs-competency" relation between Competency and Employee, a service selecting relevant learning opportunities computes the "is-relevant-for" property, and a service for learning program compilation computes Learning Program entities and their composition relationship. Furthermore, during service execution, these services make use of the ontology and its inferencing capabilities, e.g., the derivation of competency subsumption based on competency relationships.

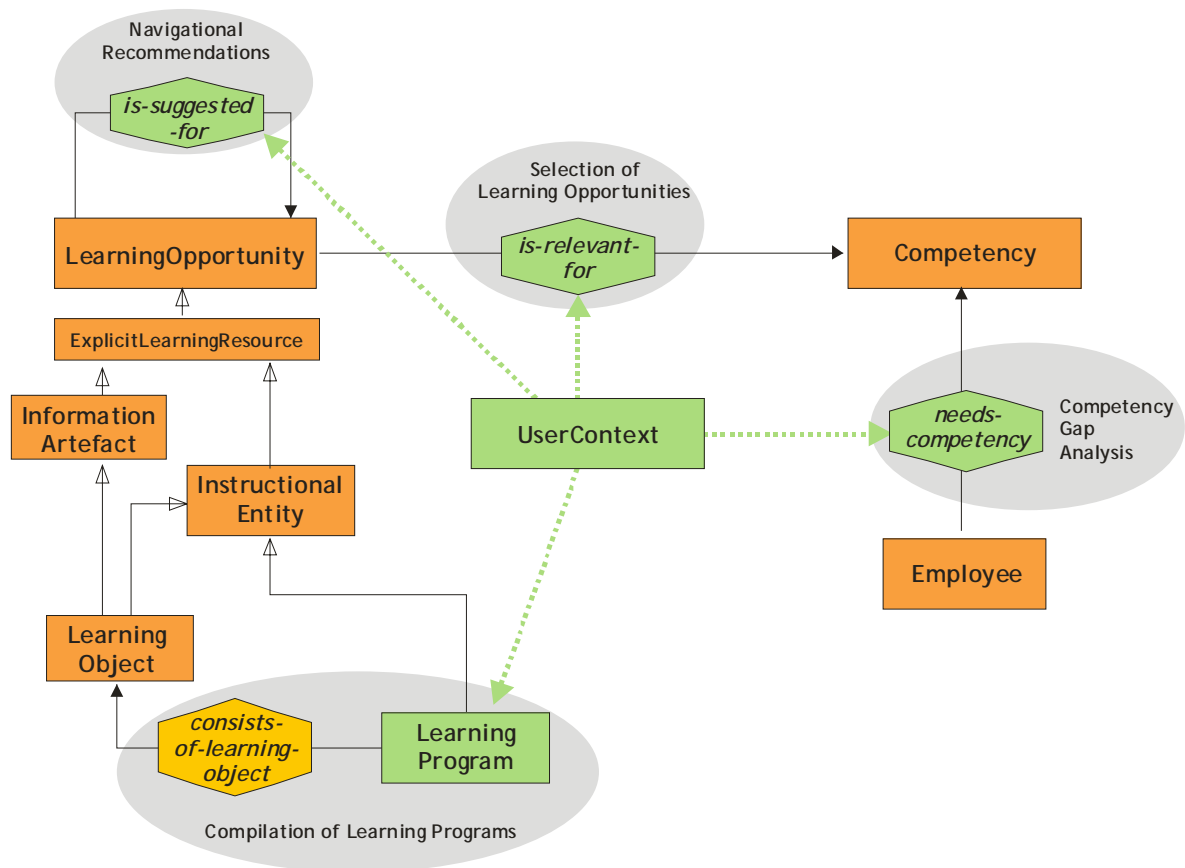


Figure 3: Ontology-centered design of services

## 5. Pilots and Results

The presented methodology was piloted in a German hospital in the nursing area in order to improve their training processes [1], which are an important element of quality assurance and patient satisfaction, but which are also very expensive.

In an initial phase, interviews and interactive workshops bootstrapped the competency modeling and established (slowly, but steadily) a thinking in competencies on all levels, which included the nurse management, the ward management, and the nurse level. Pilot stations were selected as part of a larger knowledge management initiative; active participation in the pilot was completely voluntary. Competencies were identified based on (a) existing job profiles (which were often too vague and had to be thoroughly refined) and (b) the current training programme and the learning goals of the individual events, but in the end many of the competencies had to be modelled from scratch in a moderated process largely focused around a mindmapping technique. The nursing domain turned out to be very complex (in comparison to other business domains in which competence management has been applied so far), which resulted in competency catalog with more than 600 competencies (collected and structured within a period of 6 months).

In a second phase, the processes were defined based on our reference process model with assigning responsibilities to nurse management, ward management and individual employees as well as the training department and embedding the new processes into existing ones like management by objectives. For supporting these processes, simple tools were developed for which a SAP HR-compatible replacement is planned in the large-scale rollout to the complete hospital.

The experiences from the first pilot were quite promising and have shown several opportunities of improvement for the large-scale roll-out:

- *Thinking in competencies* was hard to establish and turned to be the crucial element in implementing the processes. This applies to the identification and modelling of competencies and to the assessment of employee competencies. So the introduction of competence management also requires a change in the mental attitude, which has to be addressed by interactive workshops.
- *Modelling effort* is considerable and should be reduced by developing competency frameworks for the healthcare domain (some initial developments are in place like the NHS Knowledge & Skills Framework [8]).
- Dealing with a competency catalog with several hundreds of competencies require *new tools for navigation and modelling*. Current solutions are not geared towards that level of complexity. This encompassed more intuitive interfaces and a higher level of automation in the processes.

Especially the second problem has been addressed with competency-driven and ontology-driven learning support services were piloted within the EU project Learning in Process [3] and a subsequent industrial research project with SAP. This included services for computing competency gaps (i.e., learning needs) based on the current working context of the employees and the associated requirement profiles and their competencies and recommendation services for learning opportunities (as described above). The resulting system for learning on demand was piloted within two SMEs. The evaluation yielded a high level of acceptance among employees which so far had hardly been supported by human resource development activities at all.

## 6. Conclusions

The presented reference ontology and reference process model provide pathways for implementing competency-oriented approaches within companies. The use of ontologies enables the partial automation of processes, which is a success factor for large-scale usage. And the competency ontology as a mediating artifact that is used both on the strategic and the operational level makes discussions more fruitful and ensures the sustainability: changes to the catalog get immediate (and partially measurable) feedback from the operational level. Combined with suitable modelling methodologies, this can realize agile competence development of employees and the organization.

The presented ontology-based approach furthermore complements bottom-up activities like IEEE RCD (Reusable Competency Definitions), which can be seen as the elementary building block for defining competency ontologies, and HR-XML (which represents a syntactical layer for interoperability in the HR domain). This means that future standardization activities also need to include the semantic layer to foster reuse of modelling efforts. Contributing to that will be part of the work of the Ontology Outreach Advisory (OOA, <http://www.ontology-advisory.org/>) and its HR chapter.

Future work on the scientific side will explore technical reference architectures for competency-orientation and suitable tools for applying the maturing approach [7] to competency modelling. Especially the latter will increase the agility of HRD by complementing traditional top-down approaches with more flexible bottom-up approaches for early detection of changes.

## References

- [1] Christine Kunzmann, Andreas Schmidt: Ontology-based Competence Management for Healthcare Training Planning - A Case Study: In: 6th International Conference on Knowledge Management (I-KNOW 06), Graz, 2006
- [2] Andreas Schmidt, Christine Kunzmann: Towards a Human Resource Development Ontology for Combining Competence Management and Technology-Enhanced Workplace Learning In: Robert Meersman and Zahir Tahiri and Pilar Herero (eds.): On The Move to Meaningful Internet Systems 2006: OTM 2006 Workshops. Part I. 1st Workshop on Ontology Content and Evaluation in Enterprise (OntoContent 2006), Lecture Notes in Computer Science vol. 4278, Springer, 2006, pp. 1078-1087
- [3] Andreas Schmidt: Bridging the Gap between Knowledge Management and E-Learning with Context-Aware Corporate Learning Solutions. In: Klaus-Dieter Althoff and Andreas Dengel and Ralph Bergmann and Markus Nick and Thomas Roth-Berghofer (eds.): WM 2005: Professional Knowledge Management - Experiences and Visions, Contributions to the 3rd Conference Professional Knowledge Management - Experiences and Visions, April 10-13, 2005, Kaiserslautern, Germany, 2005, pp. 170-175
- [4] Ernst Biesalski, Andreas Abecker: Human Resource Management with Ontologies, 3rd Conference Professional Knowledge Management – Experience and Visions, Springer, LNCS vol. 3728, 2005
- [5] Mikko Laukkanen, Heikki Helin: Competence Manager—Applying the Semantic Web in Practice, ISWC 2004
- [6] Martin Hepp: Possible ontologies: How reality constraints building relevant ontologies. IEEE Internet, 2007
- [7] Simone Braun, Andreas Schmidt, Andreas Walter: Ontology Maturing – A Collaborative Web 2.0 Approach to Ontology Engineering, Proceedings of the Workshop on Social and Collaborative Construction of Structured Knowledge at the 16th International World Wide Web Conference (WWW 07), Banff, Canada, 2007
- [8] Department of Health (UK): The NHS Knowledge and Skills Framework, October 2004, [http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH\\_4090843](http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_4090843)