People Tagging & Ontology Maturing: Towards Collaborative Competence Management

Simone Braun, Christine Kunzmann, Andreas Schmidt

FZI Research Center for Information Technologies, GERMANY

Abstract. Competence Management approaches suggest promising instruments for more effective resource allocation, knowledge management, learning support, and human resource development in general. However, especially on the level of individual employees, such approaches have so far not been able to show sustainable success on a larger scale. Piloting applications like expert finders have often failed in the long run because of incomplete and outdated data, apart from social and organizational barriers. To overcome these problems, we propose a collaborative competence management approach. In this approach, we combine Web 2.0-style bottom-up processes with organizational top-down processes. We addressed this problem as a collaborative ontology construction problem of which the conceptual foundation is the Ontology Maturing Process Model. In order to realize the Ontology Maturing Process Model for competence management, we have built the AJAX-based semantic social bookmarking application SOBOLEO that offers task-embedded competence ontology development and an easy-to-use interface. Following evolutionary prototyping within the design-based research methodology we conducted two field experiments in parallel with the system development in order to test the approach of people tagging in general and to explore motivational and social aspects in particular.

Keywords: ontology maturing, people tagging, collaborative competence management, social semantic bookmarking, SOBOLEO, motivation, human resource development

1 Introduction

Competence management has received increasing attention as the implementation of a systematic approach to human resources management, e.g., part total of quality management approaches like European Foundation of Quality Management (EFQM). Furthermore, trends like recurring shortage of skilled workers and the anticipated demographic changes have led to an increasing awareness about employees' capabilities.

One reason for that is the fact that competencies have proven useful as an abstraction of work-relevant human behavior in a variety of contexts and across dif-

ferent actor groups (individual, organization, and market; see fig. 1). Within an organization, competencies enable instruments for more effective resource allocation (e.g., for team staffing), knowledge management and informal learning support, and human resource development in general. They aim at making transparent individual competencies and their relationship to organizational goals. Recently, this view has been complemented by the usage of competencies in employability processes, ranging from competencies as part of e-portfolios, via competency-based curricula up to competency-driven recruitment processes.

Fig. 1. Use cases for competence models and catalogs.

However, especially on the level of individual employees, such approaches have so far not been able to show sustainable success on a larger scale [33]. Piloting applications like expert finder or expert locator systems have often failed in the long run because of incomplete and outdated data, apart from social and organizational barriers. This affects both competency profiles of the individual employee and non-adequate and often also outdated competency catalogs used as a vocabulary for the profiles.

In this contribution, we argue that a lack of participation of all employees has been one of the key problems. To overcome this, we propose a collaborative ap-

proach based on Web 2.0-style people tagging and complement it with community-driven ontology engineering methods.

As a first step, we analyze current approaches to competence management (section 2), before describing our approach based on people tagging (section 3). In section 4 we describe our tool support with the social bookmarking application framework SOBOLEO and present an evaluation in section 5. In section 6, we briefly compare our approach to the state of art and conclude with a brief summary and outlook.

2 Competence Management Approaches and their Problems

2.1 Competence Management Approaches in General

Traditionally, competence management approaches are conceived as top-down instruments (see, e.g., [5, 6]) and are based on controlled vocabularies in the form of competency catalogs. In such approaches, a small expert group models such competency catalogs and thus defines the vocabulary at irregular intervals (usually well more than yearly) or even as a one-time activity without scheduled updates [1]. This catalog is then provided to the lower management and the employees in order to provide, update, and apply requirements and competency profiles.

As noted by Kunzmann & Schmidt, this method usually leads to communication and coordination problems between strategic and operational level. They have proposed a closed-loop approach (see fig. 2) in which two-way communication between the different levels forms an integral. This model is designed from a human resource development perspective. On the strategic level, the competence catalog and the requirement profiles for job roles are modeled in a continuous loop, taking into account corporate goals (in order to ensure that the catalog and the profiles are oriented toward the future) and feedback from the operational level. The operational level uses this vocabulary to describe the actual competency profiles of the individual employees. By comparing the actual competency profile with the requirements profile, it is possible to determine a competency gap, which can be addressed by development measures. Their outcomes should then improve work performance, which provides the indicators for setting up competency profiles, but also competency aspects which are not yet included in the competence catalog and thus have to be fed back to the strategic level.

As a summary, core competence management activities include:

- *Competency modeling* as the activity that identifies, describes, and relates competencies to other competencies and has the competency catalog as its result (sometimes also referred to as “competence model” – although this in some contexts refers to a meta-model for competency descriptions).

- *Requirements elicitation* stating which competencies are needed for a certain job role (now and in the future), which may include a differentiation into minimum requirements and development pathways.
- *Diagnostics/assessment* as the activity of making explicit actual competency profiles of individuals based work performance and other assessment techniques.

But even with a closed loop approach as outlined, there are still considerable problems when putting those approaches into practice. We will analyze in the following the competence modeling and diagnostics/assessment activities, which are in practice the most challenging ones.

Fig. 2. Reference model for closed-loop approaches to competence management.

2.2 Getting Competency Profiles

On the operational level, the most obvious problem is getting the competency profiles. One fundamental issue is that competencies cannot be measured, sensed, or observed directly. What we can observe is performance [22] in various forms: assessment of learning outcomes, performance in every day job activities etc. All of these yield evidence from which a competency is usually deduced heuristically.

In practice, you can observe two approaches [6]: (1) self-assessment approaches in which employees themselves are asked to provide their competencies, sometimes mediated in a second step by their superior, and (2) external assessment approaches done by superiors or through formal assessment procedures.

While the latter approach is very expensive and cumbersome and thus can only be observed in limited areas, the first approach often fails because of missing motivation. This lack of motivation can be traced back to no immediate benefit for the employees. For instance, systems are hardly embedded into everyday work activities and have not proven their usefulness there. Or it can be even traced back to negative incentives; for instance, if you disclose your competencies, others will contact and perhaps disturb you or you will fear to appear not competent enough. As a result, employees might downplay or exaggerate their competencies as Becerra-Fernandez reports [1]. Often, these competency profiles also do not contain information that is of high relevance to colleagues; for instance manually-updated repositories become particularly outdated [25]. Thus, recent and usually very specialized topics are not yet contained in the competency catalog because of the long update intervals.

Several studies address this problem by automatically extracting profile information from data the user generates in her daily work; e.g. from publications [13], documents [28] or community contents [9, 20]. Ley et al. [22] propose a competence performance approach that derives competencies from executed tasks. In this approach, a task competency matrix is created together with domain experts. This matrix relates a set of tasks, e.g. required for a position, to a set of competencies needed to fulfill these tasks successfully. Based on this model, the system can infer a user's competency from her successful performance of a task in her daily work.

A different approach to employee profiles starts from the purpose of those profiles for expert finding and community formation: (enterprise) social networking, e.g., LinkedIn [23] or Xing [37]. These platforms are based on the self-promotion paradigm: People can represent themselves with a profile and indicate their connections to other users. Further, in some of these approaches, the principle of social tagging and bookmarking is transferred to people (cf. [7]); for instance Xing [37] or theNTSH [36] allow organizing your contacts with tags. Within IBM's Fringe Contacts [18], each employee can describe their colleagues by tagging them with key words on their expertise and interests. Thus, step by step, a publicly visible tag cloud grows characterizing the individual employee. This leverages network effects for setting up some sort of profile of the individual, and improves usefulness for the individual user of the system which, in turn, motivates to con-

tribute. For instance, Farell et al. [17] could state that tagging people was used to create communities.

However, the resulting profiles lack legitimation and commitment by the organization, especially with respect to the vocabulary used. The approaches do not provide support to overcome the gap and leverage the bottom-up topics to an organizational competences vocabulary. But that is a prerequisite for organizational competence management – ranging from team staffing, via human resource development to organizational competence portfolios.

2.3 Competency Modeling

That points back to the issue of competency modeling for building a shared organizational understanding. If we analyze the scientific literature, a lot of attentention has been paid to exploiting competency models for team staffing, applicant selection etc. via profile matching, but little investigation has taken place into *competency modeling processes*. Existing approaches vary in terms of modeling depth (ranging from around 20 competencies [16] up to several hundred per catalog), and structures used (flat lists [11], hierarchical structures [34], a combination of context-free generic competencies and context ontologies [11]. But all of them are based on the assumption that a small group of experts is responsible for the task of competence modeling. This ensures that the resulting catalog gets organizational legitimation & commitment.

Practical experience shows the following problems:

- Competence models are frequently outdated and do not get updated in time. Usually, competency modeling is considered to be a **one-time activity instead of a continuous improvement**.
- Competence modeling is mainly **done on a strategic level**, or as part of centralized function units, which lack information about operational needs.
- The process of competency modeling is often **just too complex**, i.e., it requires modeling skills, which are not readily available in organizations. This can be compensated as part of one-time efforts, but it poses severe challenges for continuous updating. The main issues here are that it is unclear where to start, and it is hard to provide templates to facilitate the modeling process.
- When applying the competence catalog, employees encounter the problem that (1) they **cannot understand the meaning** of competency labels (because they were not part of the modeling process – so it's language of someone else), (2) they **do not find the relevant topics** (what's interesting for them), which particularly applies to emerging topics, and (3) if they find something, it is not at a **right level of detail**.

All of these lead to the perception that competence management is actually just another administrative exercise because it is not part of vital organization processes.

3 Approach

Based on these fundamental problems, we could easily argue that competency modeling as such is the wrong path as the essential assumption that competencies are an adequate and practical model to reduce real-world complexities does not hold. But the situation is not as bleak if we analyze the problem from a semantic perspective (see also table 1 for a semantic differentiation of the most typical use cases):

- In the collection of different use cases for competencies, there are different requirements for the **level of detail** of competence modeling and profiles. Aligning corporate strategies with employee competencies is by nature on a very aggregated level, while team staffing or targeted human resource development requires fairly specific competencies.
- Similarly, **precision** for the competency notions is not always required in the same way. While anything with a direct impact on employee salaries and/or career opportunities needs a sound foundation, this is not the case for informal networking activities as part of expert finding or community formation. In the latter case, it is sufficient to know about interests or experiences, which can, but definitely do not need to relate to competencies.
- On the assessment side, **formal** (and thus objective and reliable) competence **assessment** can only be made for a small subset of competencies. Only for these we can define a sufficiently reliable set of key performance indicators. For the others, we need to rely on less formal procedures (like self or peer assessment) anyway.
- On the other hand, if we are not focused on formal assessments, we will find that there are **indicators** for competencies **everywhere**. Each single indicator is not very reliable (e.g., task performance can depend on a lot of environmental factors, which can be accidental), but the combination of a multitude of those indicators can provide good approximations (as the wisdom of the crowd principle claims).

As a summary: it appears that the observed problems can be partially traced back to the narrowed perspective which takes the use case with the highest requirements for formality, level of detail, and precision as the base standard. Our approach, which we will present in the next section, takes a differentiated approach, which allows for following a Web 2.0-style participatory approach to competence management.

Table 1. Semantic differentiation of the most typical use cases.

Use case	Requirements	Notions
People finding	Timely inclusion of emerging topics	Interest
Finding help on a problem		Experience
Community formation		
Team staffing	Sufficiently level of detail in com-	Experience

Application selection Matching requirement and actual profiles	bination with relationships for similarity measures	Competency Potential
Training planning **Human resource development** Identifying development needs and selecting measures	Sufficient level of detail, corresponding to the granularity of measures	Competency Learning outcomes
Learning on demand support Suggesting learning opportunities within the work process	Fine grained descriptions of what is relevant for a certain situation	Topics Competency
Reward schemes **Career planning**	Very reliable measurements through key performance indicators Lower level of detail	Competency (Potential)
Aligning employee competence development with corporate strategies	Small set of stable competences	Aggregated competence

3.1 General Considerations

To overcome the problems sketched in section 2, we propose a collaborative competence management approach, which combines Web 2.0-style bottom-up processes with organizational top-down processes: Web 2.0 oriented bottom-up processes allow every employee to participate and contribute with low usage barriers; i.e. by tagging colleagues; the organizational processes take up and guide these bottom-up developments towards organizational goals.

This requires bringing together the following elements:

- *Bottom-up collection of opinions about individual competencies.* Instead of cumbersome (top-down) processes to assess an employee's competencies, we make use of the "wisdom of the crowd" effect and collect the collective view of the community of employees on the competencies of the individual. Therefore, we need to empower the employees to describe each others' competencies in an easy and task-embedded way.
- *Freedom to evolve competence vocabulary.* Employees need to be enabled not only to state their opinion on who has which competency, but they have to be enabled to modify the vocabulary for stating those opinions as well. Otherwise, we do not exploit the ability of bottom-up processes to detect new trends.
- *Shared vocabulary for comparability*. Competencies usually have an integrating function in the enterprise, bringing together strategic and operational levels, and human resources, and performance management aspects. This means that competencies are not limited to an individual or to a group, but these notions have to be shared by the whole organization (in the ideal case): in consequence we cannot do without a shared vocabulary.

- *Legitimation and commitment by the organization.* If competencies are to play an important role in diverse organizational processes, ranging from team staffing, via human resource development process, up to organizational competence portfolio management, it is important that resulting competency profiles and competency cataloges are not only derived from the "wisdom of crowd", but have also the commitment of the organization. This is a main difference to the open world of the web of individuals. Major decisions depend on the appropriate identification of competencies and competency profiles so that the organization must *decide* at some point to which extent it relies on the result of collective bottom up processes and to which extents it defines certain binding aspects.

As a summary: the key idea is that we cannot do competence management completely without an agreed vocabulary (or ontology), i.e. the competency catalog. But we have to make the process of evolving this catalog more collaborative and embedded into its actual usage (e.g., while tagging other employees). Likewise, we do not conceive competency profiles as self-descriptions, but rather as results of collective judgments of others (cf. [18]).

3.2 Ontology Maturing Process for Evolving Competence Catalogs

We approached this problem as a collaborative ontology construction problem. The conceptual foundation is the Ontology Maturing Process Model [8] (based on a more general Knowledge Maturing Process [30]). The Ontology Maturing Process Model (see fig. 3) is based on the assumption that ontologies, i.e. competency catalogs, cannot be formalized in a single activity. They are rather the result of continuous negotiation and collaborative learning processes that take place when applying the ontologies. The model structures the process of evolving competence ontologies into four phases:

1. **Emergence of ideas.** By employees annotating each other with any topic tag, new topic ideas emerge. For instance, they describe a recent or very specialized topic. These topic tags are individually used and informally communicated.
2. **Consolidation in Communities.** A common topic terminology evolves through the collaborative (re-)usage of the topic tags within the community of employees. The topic tags are defined and refined, useless or incorrect ones are rejected.
3. **Formalization.** Within the third phase, the special members of the community (usually legitimated by the organization by assigning "gardening" tasks) begin to organize the topic terminology into competencies by introducing relations between the topic tags. These relations can be taxonomical (hierarchical) ones as well as arbitrary ad-hoc relations, expressing similarity (e.g., Java Programming and C# Programming). That results in new or updated

competency notion, i.e. lightweight ontologies, which allow primarily for inferencing based on subconcept relations.

4. **Axiomatization.** In the last phase, modeling experts add axioms for exploiting relationships for reasoning. This includes especially precise composition relationships. This allows and improves for complex inferencing processes, e.g. subsumtion of competencies for the purpose of competency gap analysis, or competency-based selection of learning opportunities (cf. [33]).

It is important to note that ontology maturing does not assume that the competence ontologies are built from scratch. It can be equally applied to already existent core competency catalogs that might be further developed and can be used for seeding.

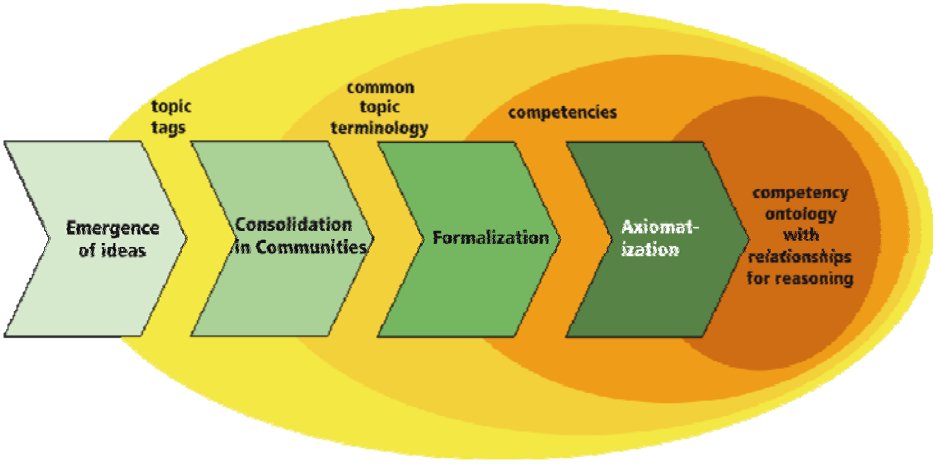

Fig. 3. Ontology Maturing for Competence Ontologies.

3.2.1 Competence Ontology Maturing in Corporate Practice

If we translate this to corporate practice, we can distinguish between different roles (or levels of involvement) and expected skills:

- In the first phase, we mainly rely on a large number of individual employees with little or no knowledge about competence modeling. They are mainly concerned with their task at hand and use tagging practices to find people later on more easily. They can align themselves with other colleagues through observing their tagging behavior and potentially through tag suggestions (which essentially is a system-mediated observation of the behavior of others).
- In the second phase, we rely on gardeners that partially and incrementally consolidate the tags, usually focused on areas with a high volume and heterogeneity of tags. These gardeners are usually not in a special centralized function unit, but rather emerge from their peers (but can be equipped with organizational le-

gitimation from their superiors) because of their interest and mission. They play the important role of facilitators of the consolidation process although they do not accomplish the task alone. These gardeners do not necessarily need to be experts in competency modeling, but need basic semantic modeling know-how to discover problems and suggest solutions.

- For core areas, which are important to formalize, experts or expert groups will be responsible. These are similar to the experts in the traditional approaches, but as opposed to those, they are now informed about what is considered important by employees as part of their daily activities.

3.3 Different Levels of Formality for Different Use Cases

One important conclusion from the ontology maturing model is that the different phases result in different levels of formality. These different levels of formality co-exist within a single competence model. But how can we represent these different levels of formality so that we can also exploit the information?

As part of the Professional Learning Ontology, we have developed a conceptualization of competencies that has three basic levels: topics (as weak notions), competency types (without differentiation) and competencies (with levels). These relate to each other as shown in fig. 4.

In this way, we can (1) represent all four phases of the ontology maturing process and (2) degrade the semantics of more formal statements if needed. Especially, the latter is important for the different use cases of competence models [33]:

- *Topic tags.* As many Web 2.0 sites show or [18], tags are sufficient to provide a basic level of useful search and retrieval functionality and similarity between the tagged resources. Precise tag definition would help, but are not needed.
- *Competence types.* For basic profile matching, we need well-defined competency notions and taxonomic relationships to allow for different levels of abstraction by using broader-narrower relationships. We can also perform basic competency gap analysis (by exact matching).
- *Competencies (with levels).* This allows for a more extended version of profile matching as you can have different degrees of fulfillment for individual competencies. This can also form the basis for describing the objectives of learning opportunities (trainings, learning objects).
  Competency relationships. If we have precise is-a semantics, or composition of competencies in the competence model, we can introduce the notion of competence subsumtion (see [32]), e.g., if competency X is part of competency Y, X subsumes Y. This allows for more sophisticated competency gap analysis (as in [31]), and competency-based selection of learning opportunities.

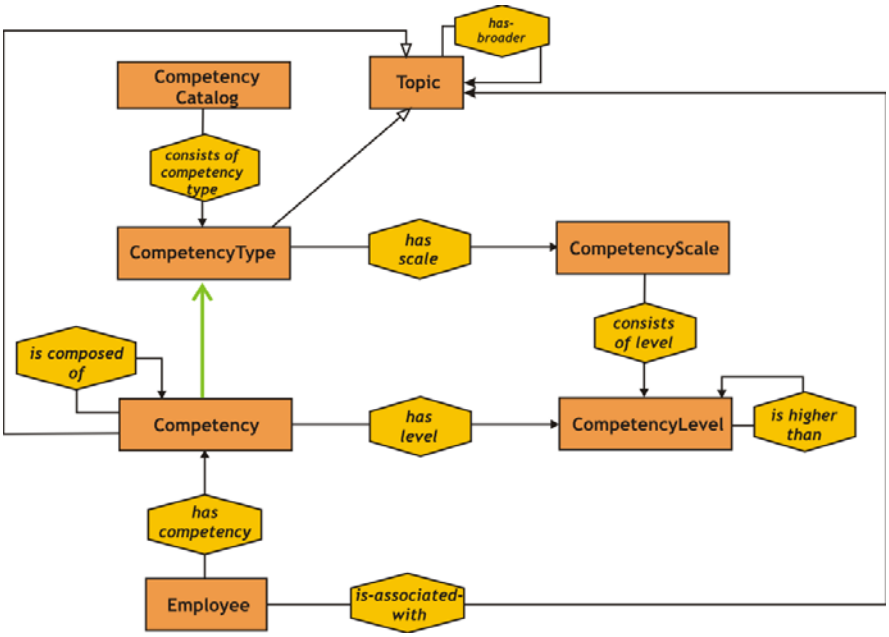

Fig. 4. Core part of the Professional Learning Ontology.

4 Tool Support

In order to realize the Ontology Maturing Process Model for competence management, we rely on the social bookmarking paradigm and have customized the AJAX-based semantic social bookmarking application SOBOLEO that offers task-embedded competence ontology development and an easy-to-use interface. SOBOLEO [38] is the acronym for **So**cial **Bo**okmarking and **L**ightweight **E**ngineering of **O**ntologies. It supports the collaborative development of a shared bookmark collection (e.g., of people's web pages in an intranet) and of a shared competence ontology that is used to organize the bookmarks to people. That means users can tag the people's web page with ontology concepts, and at the same time they can modify and adapt the competence ontology.

4.1 Technical Realization

SOBOLEO consists of four major parts: (1) a collaborative real time editor for changing the competence ontology (see fig. 5), (2) a tool for the annotation of web pages (see fig. 6), (3) a semantic search engine for the annotated bookmarks, and (4) an ontology browser for navigating the competence ontology and the content of the bookmark collection.

With SOBOLEO, all users create and maintain one competence ontology and one shared bookmark collection collaboratively. If the users encounter a resource, e.g. a colleague's profile or homepage, they can add it to the bookmark collection and tag it with concepts from the competence ontology (see fig. 5). In the case they want to tag the resource with a topic the existing ontology concepts do not cover (e.g. because the topic is too new or specific), the users can adapt an existing concept (second phase of the ontology maturing process) or just use new topic tags, without an agreed meaning (first process phase). These new topic tags are automatically added to the ontology as "prototypical concepts", reflecting the fact that it's not clear yet how they relate to the existing concepts.

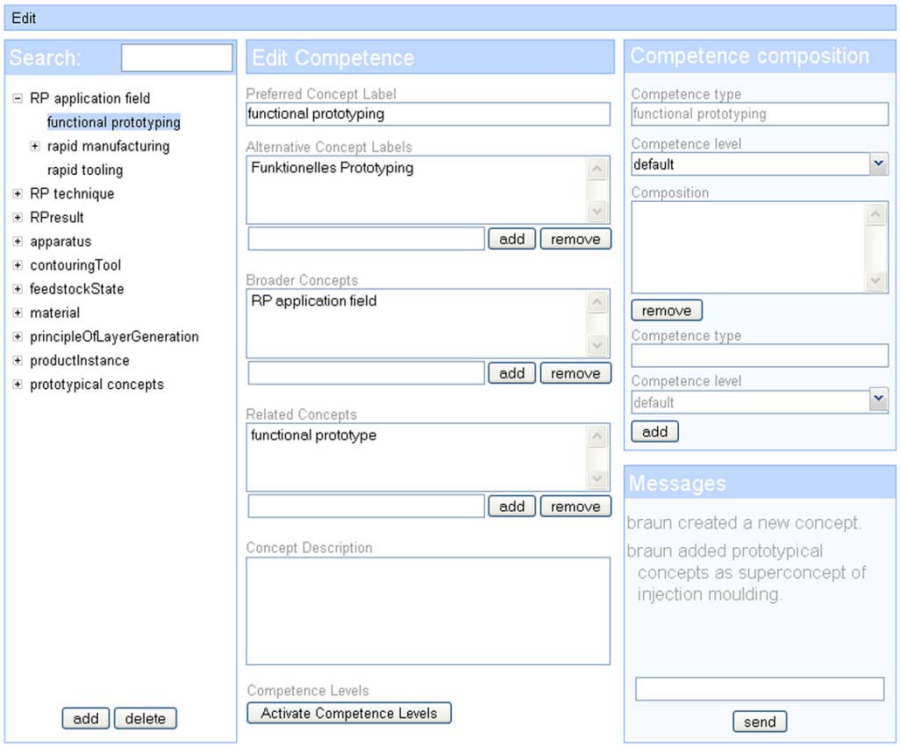

Fig. 5. Collaborative Competence Ontology Editor.

SOBOLEO provides consolidation support for the gradual formalization of these new topic tags to competence types and competencies with levels. By providing an easy-to-use and easy-to-access collaborative real time editor, the users can refine and correct concepts when they apply the competence ontology within their everyday activities. By removing topic tags from the "prototypical concepts" container and integrating them into the ontology and adding additional information, topic tags are transferred into competence types and competencies with levels. In this way, the users can easily bring topic tags to competence types and competencies with levels.

As standard and formal ontology language we use the SKOS Core Vocabulary [26] and the SKOS Extensions Vocabulary [27]. By its lightweight and intuitive language it supports to handle the tradeoff of having different levels of formality and an easy understandability for non-modeling experts. In this way, users can structure the concepts within SOBOLEO with hierarchical relations (broader and narrower) or indicate that concepts are "related" which supports the third process phase. These relations are also considered by the semantic search engine. That means the user can improve the retrieval of the annotated bookmarks by adding and refining ontology structures.

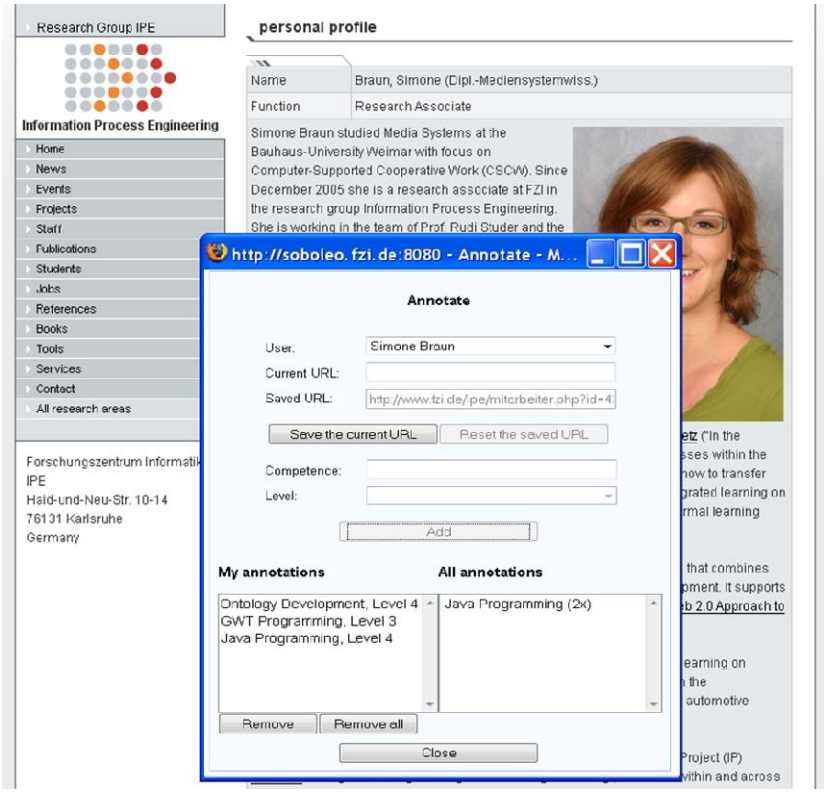

Fig. 6. Annotating an Employees Personal Web Page.

4.2 System Architecture

The SOBOLEO system is realized in a multi-tier architecture with four layers (see fig. 7):

- *Presentation/Interface Tier:* realizes the interfaces of the application, i.e. web and service interfaces
- *Application Logic Tier:* realizes the application behavior, e.g. semantic search logic that utilizes both ontology and documents (e.g. a person's web page)
- *Domain Tier:* manages the domain objects (user, ontology, annotation, documents) on top of the data storage
- *Data Tier:* realizes the efficient and persistent storage of the application data

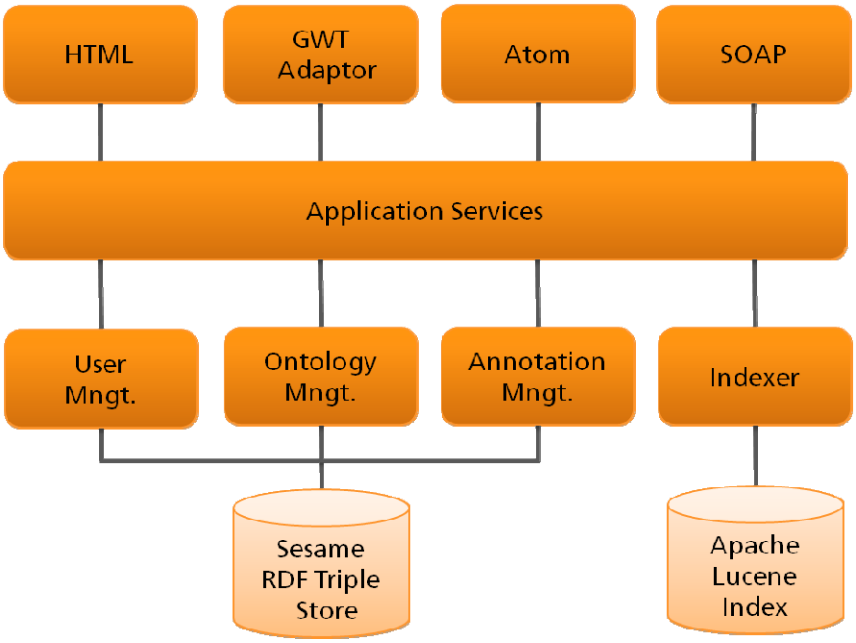

Fig. 7. SOBOLEO Architecture

SOBOLEO is implemented in Java 6 on top of the Apache Tomcat 6.0 application server [3]. The four tiers will be detailed in the following. The presentation/interface tier realizes the user interface of the semantic search and the ontology browser using Java Server Pages; the AJAX interfaces of the ontology editor and annotation tool are created with Google's Google Web Toolkit framework [19] to offer real time interactions. In addition, we provide an Atom feed interface that allows the subscription for recent changes about annotations (for a specific competence or the entire competence ontology). Using the Apache Axis2/Java

1.4.1 SOAP engine [1] we provide web service interfaces, e.g. for the export of the competence ontology.

The application logic tier realizes the application services. For instance the semantic search service considers subsumtions of competences, i.e. if competency k with level l_1 subsumes competency k with level l_2 because $l_1 > l_2$ then searching for persons with (k, l_2) also finds persons annotated with (k, l_1). This means that domain-specific reasoning is implemented within those application services, which allows from an architectural point of view the flexibility to incorporate various methods for semantic augmentation in an application context specific manner.

The domain tier comprises four components which manage users, ontology, annotations, and documents on top of the data storage. The user management component is in charge of e.g. the creation and deletion of users and the provision of user data. Users are represented with the FOAF vocabulary (Friend Of a Friend) [10] and stored together with the ontology and annotations in a RDF triple store using the Sesame 2.0 RDF repository framework [35].

The ontology management component controls the competence ontology elements, e.g. checks for potential cycles produced by adding new relations. New hierarchical relations between competence types are created using skos:broaderGeneric and skos:narrowerGeneric respectively. A competence instance relation is represented by skos:broaderInstantive and the inverse skos:narrowerInstantive between a competency (with level) and a competence type:

<competenceInstanceURI, skos:broaderInstantive, competenceTypeURI>
<competenceTypeURI, skos:narrowerInstantive, competenceInstanceURI>

Between different competence instances, i.e. competencies with level, compositions relations can be defined. These are modeled using skos:broaderPartitive and skos:narrowerPartitive. Any of these relations are subproperties of skos:broader and skos:narrower respectively (see [27]).

The annotation management component handles annotations storage into the triple store. When annotating a person with a competence, it is necessary to record how often one specific competence is assigned to the person, who are the annotators, and when they made the annotation. Such reification is realized using the contexts provided by Sesame. Thus one annotation is represented by three statements:

- <annotatedUserURI, hasCompetence, competenceInstanceURI, contextURI>
- <contextURI, addedBy, annotatingUserURI, dateContextURI>
- <dateContextURI, dateAdded, date>

The fourth component is the indexer component that controls the storage of the annotated person's web page (content, url, title) together with the competences used for annotation for fast retrieval. The index of documents is build on top of the open source framework Apache Lucene 2.3.1 [2].

5 Evaluation

With the development and implementation of our approach we follow evolutionary prototyping within the design-based research methodology [14]. In order to test the approach of people tagging in general and to explore motivational and social aspects in particular, we conducted two field experiments. The field experiments took place in parallel with the system development and thus based on paper prototypes.

5.1 Procedure

Two research groups within the area of computer science were involved in the field experiments. Group I consists of 50 people from two organizations; Group II consists of 63 people distributed over four organizations where some of the people belong to both research groups. Work atmosphere within both groups is frank and friendly. People work together closely to very closely within their organizations, less closely across organization borders.

Both groups lacked awareness about the people's topics, interests and competencies within the groups. They wanted to better exploit synergies and to know whom to ask for a problem at hand. Neither of the groups had competence management established, but it was considered to introduce such within Group I in order to improve/facilitate a) team staffing and b) career planning. Both groups were open for new technologies and familiar with tagging, Web 2.0 and semantic technologies (as they are doing research and software development in this area). They were not familiar with competence management.

The first field experiment (FE I) took place with 39 participants of Group I in July 2008, the second field experiment (FE II) with 38 participants of Group II in September 2008. 17 people participated in both field experiments. The field experiments took place in the course of each research group's internal retreat. During these retreats, people tagging was an explicit item on the agenda and task during the three days of the retreat.

We prepared paper-based posters for each group member (including not participating members). Each poster showed the name and photo of the person and blank lines to write down tags. We prepared a seed list of tags. This seed list consisted of topics the people are dealing with in their daily work. This list was meant for inspiration and stimulation of the participants to start tagging.

There was an opening presentation in order to introduce the topic of competence management and people tagging, the task, and the purpose of the experiment. The given task was:

- Please tag your colleagues and yourself according to the interests you associate with them (by writing the tag on the poster)
- Use whatever tag you find appropriate

- Use some from seed list, or ignore them completely
- Reuse tags of others
- Indicate also if you assign the same tag as already there (by repeating the tag or by adding a multiplying factor)

We asked the participants to start walking around and tagging and to continue with the tagging in the following two days. From time to time, we encouraged the participants in doing so. Compared to FE I, in FE II no timeslot exclusively dedicated for people tagging was foreseen in the agenda. Additionally, due to unforeseen circumstances, the introductory slides could not be presented in FE II. The introduction took place orally but without clearly communicating the background and purpose.

At the end of each field experiment, an extended discussion session together with the participants took place. After both experiments were conducted, all members of the groups were asked to fill out a short online survey. People who are member of both field experiments were asked to fill out one survey for each. In total, 29 members of each research group answered the survey (cf. Table 3).

5.2 Results

Overall people tagging has been regarded as positive and useful. People enjoyed the experiments and stated that “it was fun”. Table 2 shows an overview on the statistical data of both field experiments in comparison.

Table 2. Statistical data overview of both field experiments in comparison.

	FE I	**FE II**
# posters	50	63
# participants	39	38
# unique tags	585 (156 off-topic = 27%)	485 (226 off-topic = 47%)
# tag applications	1807	1296
# tag reuse/tag	Ø 3,10 (median: 2)	Ø 2,67 (median: 2)
# tags/person	Ø 15 (median: 11)	Ø 11 (median: 9)
# tag applications/person	Ø 37 (median: 32)	Ø 21 (median: 15)

The participants appreciated reflecting about others’ interests and competencies: “tagging people forces you to think about what you actually know about others”. They liked “to learn about others” and “to get new insights” in this way, in

particular about people they are not so much in contact with. With the tags it was possible to get a quick overview and to see who works in the same area as oneself or has similar, also non-work related, interests (see also Table 3). The participants expressed the wish to have tool support that facilitates finding similar people or comparing people based on their tags. Concerning individual reflection, the participants enjoyed to see how others perceive them and what they associate with them.

It was stated that with single words a description is possible and that the tags "converge to the right results". However, the participants also complained that tags are sometimes not expressive enough or misleading. They indicated that having more context and semantic information would be desirable. It happened that different tags were used for the same concept even on the same poster (e.g. use of both 'Personal Knowledge Management' and its acronym 'PKM'). The seed list was recognized only rarely as it was not integrated into the actual tagging process; i.e. the participants forgot about the list while tagging. The participants wished to have auto completion and suggestion support with more "semantics" during the tagging process. These issues were directly integrated into the software development process of SOBOLEO.

Another issue the participants raised was the difficulty to start tagging from scratch with a blank sheet. Here again the participants asked for support functionalities or seeding, e.g. everyone tags oneself at first. On the other hand, another group of people stated that seeing the already assigned tags biased them towards confirming these tags instead of adding new ones.

In total the participants enjoyed people tagging as a social activity, i.e. walking around, meeting other participants in front of the posters and jointly reflecting about skills, competencies and (non-work related) interests.

At the same time, however, the joint reflection and discussion about other persons was also perceived as negative because it resulted in "talking about" instead of "talking with" people. This was particularly problematic in FE II where due to the missing introduction of people tagging some serious social issues arose. In FE II, a small number of participants saw people tagging as an intrusion into their privacy – they objected in particular to off-topic (non-work related) tags and to a small number of slightly offending tags. Interestingly even tags not seen as problematic by both tagger and taggee caused problems when read by people lacking the context needed to understand them in the playful way they were intended.

FE II has shown that it is very important to clearly communicate the purpose of people tagging, i.e. what it is intended for and why it is used and what happens with the data afterwards. It should be decided and communicated beforehand how to handle off-topic tags in general and that (even slightly) offending tags are not allowed.

Some participants of FE II also perceived the (partial) anonymity of tagging, i.e. that it was generally untraceable who tagged whom, as negative and as one reason for the high number of non-work related tags.

The general fear of transparency also arose as an important issue. The participants asked for more control over the tags assigned to them, i.e. that they should be able to decide which tags are publicly visible and which not. Some participants also asked for the possibility to opt out of people tagging altogether, to indicate

that they don’t want to be tagged, to display only self given tags (with only them being able to see tags by other people) or to disable tags from other people.

Table 3. Survey data overview of both field studies in comparison.

	FE I		FE II	
# participants	29		29	
Did you learn something new about your colleagues?	yes:	19	yes:	16
	don‘t know:	6	don‘t know:	9
	no:	2	no:	2
	n.n.:	2	n.n.:	2
Did you learn something new about how your colleagues see you?	yes:	13	yes:	14
	don‘t know:	2	don‘t know:	3
	no:	13	no:	10
	n.n.:	1	n.n.:	2
Concerning the number of tags: Were you tagged with	more:	10	more:	4
	less:	4	less:	4
	as expected:	10	as expected:	11
	don‘t know:	5	don‘t know:	9
	n.n.:	0	n.n.:	1
Did you tag yourself?	yes:	11	yes:	6
	no:	16	no:	21
	n.n.:	2	n.n.:	2

6 Summary

6.1 Comparison to Traditional Approaches

People tagging represents a bottom-up approach to competence modeling, while classical approaches were characterized by top-down expert groups. If we com-

pare our approach to those classical approaches to competence management, we can identify the following differences:

Table 4. Comparing people tagging with classic approaches

	Classic approaches	**People tagging approach**
Modeling paradigm	Expert group modeling informed by workshops with operational departments	Participatory modeling in which expert modelers are "gardeners", consolidating bottom-up input
Modeling frequency	Rather long periods between updated	Continuous modeling
Complexity of modeling competencies and their relationships	Lack of guidance of what is important and how it relates to others	Modeling process can be informed through existing tags
Perceived usefulness	Appears to be other-directed and without immediate use for the operational level	Participation of all employees according to their needs, thus also creating a form of identification with the result
Effort of competence modeling	Requires dedicated expert groups that need to conduct and moderate the modeling process in its entirety.	Effort is distributed Reduced effort for involved experts

6.2 Conclusions and Outlook

Our approach of collaborative competence management provides a solution to overcome the hitherto strictly top-down competence management approaches. In this way, competence ontologies can be developed that also cover less formalized topic tags and structures. This guarantees usefulness and timeliness when being applied.

The field studies have shown that it is possible to retrieve competencies from tags and that it supports reflection about individual and organizational competencies. However, they also identified important societal and privacy issues that must be addressed. Addressing these issues must be done both with respect to the introduction process and tag visibility controls. Especially the proper introduction and communication of purpose have emerged to be one of the most important issues. Therefore a methodology for introducing and implementing people tagging should be elaborated and further research on organizational and social constraints related to culture and atmosphere as well as on implications of people tagging is necessary.

With SOBOLEO's embeddedness into everyday work activities and easy usage, employees are motivated to contribute. If users discover that a topic is missed within the ontology, they can simply add it. If they cannot find a colleague

under the estimated topic or not at all, they can just add a new bookmark and tag it appropriately. These annotations we want to use in a next step for automatic profile generation.

Extending SOBOLEO's functionality for subsumtion and composition support by introducing *is-a* and *is-part-of* relations as subproperties of the broader relation introduces also higher complexity for the users; we are evaluating within the EU IP MATURE[1] how the users deal with this.

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References

1. Apache Axis2. Apache Axis2/Java is a Web service engine implementing SOAP. http://ws.apache.org/axis2/ (2009) (accessed 2009-03-30)
2. Apache Lucene. Apache Lucene is a high-performance, full-featured text search engine library written entirely in Java. http://lucene.apache.org/, (2009) (accessed 2009-03-30).
3. Apache Tomcat. Official reference implementation for the Java Servlet and JavaServer Pages technologies. http://tomcat.apache.org/, (2009) (accessed 2009-03-20)
4. Becerra-Fernandez, I.: Searching for experts on the Web: A review of contemporary expertise locator systems. ACM Transactions on Internet Technologies, (6)4, pp. 333-355, ACM,New York, NY, USA (2006)
5. Berio, G.; Harzallah, M.: Knowledge Management for Competence Management. J.UKM 0(1) (2005), pp. 21-28
6. Biesalski, E., Abecker, A.: Human Resource Management with Ontologies. In: Professional Knowledge Management. 3rd Biennial Conference, WM 2005 Kaiserslautern, Germany, Springer (2005), pp. 499-507
7. Bogers, T., Thoonen, W., & Bosch, A. van den: Expertise Classification: Collaborative Classification vs. Automatic Extraction. In: Proceedings of the 17th annual ASIS&T SIG/CR workshop on Social Classification, Austin, TX, USA (2006)
8. Braun, S.; Schmidt, A.; Walter, A.; Nagypal, G.; Zacharias, V.: Ontology Maturing: a Collaborative Web2.0 Approach to Ontology Engineering. In: Proceedings of theWorkshop on Social and Collaborative Construction of Structured Knowledge at 16th International World Wide Web Conference (2007)
9. Breslin, J.G., Bojars, U., Aleman-Meza, B., Boley, H., Mochol, M., Nixon, L.J.B., Polleres, A., Zhdanova, A.V.: Finding Experts Using Internet-Based Discussions in Online Communities and Associated Social Networks, The 1st International ExpertFinder Workshop, Berlin, Germany (2007)
10. Brickley, D., Miller, L.: FOAF Vocabulary Specification 0.91. Namespace Document 2 November 2007 – OpenID Edition. http://xmlns.com/foaf/spec/ (2007)

[1] http://mature-ip.eu

[2] http://www.im-wissensnetz.de

11. De Coi, J., Herder, E., Koesling, A., Lofi, C., Olmedilla, D., Papatreou, O., Siberski, W.: A Model for Competence Gap Analysis. Proceedings of 3rd International Conference on Web Information Systems and Technologies (WEBIST), Barcelona, Spain.
12. Cooper, K.: Effective Competency Modeling & Reporting, New York: American Management Association, 2000
13. Crowder, R., Hughes, G., Hall, W.: Approaches to locating expertise using corporate knowledge, Int'l J. of Intelligent Systems in Accounting, Finance & Management, 11(4) (2002), pp. 185–200
14. Design-based research collective: Design-Based Research: An Emerging Paradigm for Educational Inquiry, Educational Researcher, Vol 32, No. 1 (2003), pp 5-8
15. Dittmann, L., Zelewski, S.: Ontology-based Skills Management. In: Proc. of the 8th World Multi-conference on Systemics, Cybernetics and Informatics (SCI 2004), Vol. IV, (2004), pp. 190-195
16. Draganidis, F.: An Ontology Based Tool for Competency Management and Learning Paths. In: Proceedings of I-KNOW '06, Graz, Austria (2006)
17. Farell, St., Lau, T., Nusser, S.: Building Communities with People-Tags. In: INTERACT (2), LNCS, Springer (2007), pp. 357-360
18. Farell, St., Lau, T., Nusser, S., Wilcox, E., Muller, M.: Socially Augmenting Employee Profiles with People-Tagging. In: Proceedings of the 20th annual ACM symposium on User Interface Software and Technology. New York, NY, USA : ACM, (2007), pp. 91–100
19. Google Web Toolkit. Google Web Toolkit – Build AJAX apps in the Java language. http://code.google.com/webtoolkit/, (2009) (accessed 2007-03-20)
20. John, A.; Seligmann, D.: Collaborative tagging and expertise in the enterprise. In: Proceedings of WWW 2006 Workshop on Collaborative Web Tagging (2006)
21. Klemke, R., Kröpelin, P., Kuth, C.: Ganzheitliches Kompetenzmanagement. Personalwirtschaft 2003(2), (2003), pp. 26-31
22. Lau, T., Sure, Y.: Introducing Ontology-based Skills Management at a large Insurance Company, In Modellierung 2002, Modellierung in der Praxis - Modellierung für die Praxis, (2002), pp. 123-134
23. Ley, T., Lindstaedt, S.N., Albert, D.: Competency Management Using the Competence Performance Approach: Modelling, Assessment, Validation and Use. In: Sicilia, M.A. (ed.) Competencies in Organizational E-Learning, Information Science Publishing, Hershey, PA (2006) pp. 83–119
24. LinkedIn, http://www.linkedin.com, (2009) (accessed 2009-03-20)
25. McDonald, D.W., Ackerman, M.S.: Expertise recommender: a flexible recommendation system and architecture. In: Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work (2000), pp. 231-240
26. Miles, A., Bechhofer, S.: SKOS Simple Knowledge Organization System Reference. W3C Working Draft 25 January 2008 (2008)
27. Miles, A., Brickley, D.: SKOS Extensions Vocabulary Specification. W3C Working Draft 18 October 2004 (2004)
28. Reichling, T., Veith, M., Wulf, V.: Expert Recommender: Designing for a Network Organization, In: Computer Supported Cooperative Work: The Journal of Collaborative Computing (JCSCW), 16(4-5) (2007), pp. 431-465
29. Reinhardt, K., North, K.: Transparency and Transfer of Individual Competencies - A Concept of Integrative Competence Management. In: J. UCS 9(12), (2003), pp. 1372-1380
30. Schmidt, A.: Knowledge Maturing and the Continuity of Context as a Unifying Concept for Knowledge Management and E-Learning. In: Proceedings of I-KNOW '05, Special Track on Integrating Working and Learning (2005)

31. Schmidt, A.: Enabling Learning on Demand in Semantic Work Environments: The Learning in Process Approach. In: Jörg Rech and Björn Decker and Eric Ras (eds.): Emerging Technologies for Semantic Work Environments: Techniques, Methods, and Applications, IGI Publishing (2008)
32. Schmidt, A., Kunzmann, C.: 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
33. Schmidt, A., Kunzmann, C.: Sustainable Competency-Oriented Human Resource Development with Ontology-Based Competency Catalogs. In: Miriam Cunningham and Paul Cunningham (eds.): Expanding the Knowledge Economy: Issues, Applications, Case Studies. Proceedings of E-Challenges 2007, IOS Press (2007)
34. Schmidt, A., Kunzmann, C., Biesalski, E.: Systematische Personalentwicklung mit ontologiebasierten Kompetenzkatalogen: Konzepte, Erfahrungen, Visionen. In: Norbert Gronau and Jane Fröming and Simone Schmid (eds.): Fachtagung Kompetenzmanagement - Schulung, Staffing und Anreizsysteme, Potsdam, 5.10.2006, GITO, (2006)
35. Sesame RDF repository framework, http://www.openrdf.org/, (2009), (accessed 2009-03-20)
36. theNTSH, http://thentsh.com, (2009) (accessed 2009-03-20)
37. Xing, http://www.xing.com, (2009) (accessed 2009-03-20)
38. Zacharias, V., Braun, S.: SOBOLEO – Social Bookmarking and Lighweight Engineering of Ontologies. In: Proceedings of the 1st Workshop on Social and Collaborative Construction of Structured Knowledge at 16th International World Wide Web Conference (2007)