Leveraging Semantic Technologies for Harmonization of Individual and Organizational Learning

Melody Siadaty[1,2], Jelena Jovanović[3], Dragan Gašević[2,1],
Zoran Jeremić[3], and Teresa Holocher-Ertl[4]

[1] School of Interactive Arts and Technology, Simon Fraser University, Canada
[2] School of Computing and Information Systems, Athabasca University, Canada
[3] FON, School of Business Administration, University of Belgrade, Belgrade, Serbia
[4] Centre for Social Innovation/Technology and Knowledge, Vienna, Austria

Abstract. For a successful learning organization, it is of crucial importance to have successful methods for stimulation and sharing of working and learning activities of their employees. However, there are two important challenges to be addressed: i) combination of individual and organizational incentives that motivate employees to take part in knowledge building and sharing activities; and ii) structuring of learning and knowledge building activities and their outcomes in a representation that can assure unambiguous knowledge sharing. To address these challenges, we propose a framework of individual and organizational factors for knowledge sharing and a set of ontologies that provides a systematic and interlinked representation of concepts of individual and organizational learning. On top of these proposals, we developed and here present a software solution, which has been evaluated through a case study conducted in a large enterprise context.

Keywords: Knowledge Sharing, Organizational Learning, Ontologies, Harmonization.

1 Introduction

Goal-oriented and self-directed learning are the predominant forms of adult learning, especially in workplace settings [12] [14]. Even though learning goals are typically personally defined, they are highly influenced by the overall organizational expectations and goals, as well as goals of the colleagues a person closely collaborates with (e.g., teammates). In addition, learning goals are not preset and immutable. Instead, they tend to change during the learning process, i.e., to evolve through an individual's interactions with others, and their participation in knowledge building and sharing activities [14]. To make these activities beneficial both for individuals and organizations they work for, employees should be assisted in the cyclic process of (re-)thinking, defining and attaining their learning goals. This process often involves making use of and contributing to the organization's collective knowledge, where contributions come in diverse forms such as reflections; annotations (e.g., comments and ratings) of existing resources; and exchange of ideas and problem solutions within the organization's social network.

Learning is not an isolated process, but highly social and community centered [22]. It is about building and maintaining networks through connecting with other, contributing

knowledge to the network and making use of knowledge shared by other members. Knowledge sharing has been recognized as the critical part of this process, especially in workplace learning settings [26]. By sharing their knowledge as well as using the knowledge shared by others and building on top of it, individuals can improve both their own knowledge and contribute to the collective organizational knowledge, thus, supporting their individual learning goals as well as organizational expectations. For example, an individual's knowledge of a certain topic can be improved by considering and further reflecting on reviews, comments, and suggestions obtained from peers. This requires that individuals first externalize their knowledge and share it with others. However, in practice, this is not happening as learning experiences are very rarely written down and shared [26], whilst well documented learning experiences could serve as very valuable knowledge objects that could help novices in a certain domain area in setting, refining and/or attaining their learning goals.

It is very important to indicate that individuals' contributions often originate from different systems and tools. For them to be effectively used as a part of the shared organizational knowledge, they have to be structured, organized and well annotated, so that they can be (re-)discovered and (re-)used inside organizations or publicly. Social technologies already provide means that motivate individuals (and partly organizations) to collaboratively build and share knowledge on the Web. However, they suffer from the problems of ambiguity in shared meanings and the lack of semantics (e.g., as simple as synonyms), the lack of coherent categorization schemas, and the needed time and size of the community in which they will be used [16]. Moreover, current social technologies are not or are very little context-aware and thus, it is very hard to provide a systematic harmonization of personal learning experiences with others in organizations. To address these challenges, here, we propose the use of semantic technologies. The core part of our solution is *a set of ontologies* (Sect. 4) that brings in a structure and attaches the explicit (i.e. machine-'consumable') semantics to the knowledge shared by individuals. Ontologies also add explicit semantics to the data about individuals' knowledge building and sharing activities and allow for seamless integration of this data. Finally, ontologies allow for unambiguous representation of individual and organizational goals and can facilitate the task of bringing these in line (e.g., by enabling automatic detection of how close they are to each other and generating appropriate feedback to both individuals and organizations).

While semantic technologies offer promises of better data management and sharing, it would be naïve to expect that the technology alone will solve the problem [19]. Knowledge sharing often does not happen spontaneously and there are numerous inhibitors of this process (discussed in Sect. 2). Thus, individuals need to be motivated to learn, to share knowledge and, in doing so, to follow the organization's norms and goals. This is most easily achieved when the individual and organization's goals are harmonized [17]. Additionally, adult learners need to be free to direct themselves [12]. Hence, the organization should just point the directions and expectations and not impose the behavioral/work models. The individuals should have the freedom to follow the provided suggestions or to choose their own ways of accomplishing the "negotiated" learning goals. To address these challenges and investigate them, in this paper, we present two services – Personal Learning and Knowledge Management (PLKM) and Organizational Learning and Knowledge Management (OLKM) – that we are developing to facilitate and foster learning and knowledge sharing activities both from personal (PLKM) and organizational (OLKM) perspectives. The former

service allows individuals to easily share their knowledge and to dynamically reflect about, define and adapt their learning goals, taking the learning goals of their peers and the organization into consideration [14]. PLKM facilitates all these activities irrespective of the application an employee is using in the given moment. The latter service (OLKM) allows organizations to (re-)define policies related to knowledge sharing and more importantly to receive and review the feedback about employees' knowledge building and sharing activities as well as integrate the newly learned knowledge into official organizational norms.

2   A Framework for Knowledge Sharing within an Organization

Successful knowledge sharing within an organization depends on the synergy of three main groups of factors [19]:

- Individual: motivation of individual employees to capture, disseminate, and apply existing and newly generated knowledge;

- Organizational: organizational structures that facilitate transparent knowledge flows; a well-communicated and open organizational culture; the organization's goals that clearly communicate the benefits of knowledge sharing practices; managers who lead by example and provide clear feedback;

- Technical: software solutions that allow for seamless and ubiquitous knowledge sharing, and facilitate knowledge discovery, (re-)use, and (re-)combination (mash-ups).

Accordingly, in this section, we look at different kinds of individual-level incentives and inhibitors for knowledge sharing within an organization and how they can be addressed by appropriate combination of organizational and technical factors. In this way, we identify a set of factors that we want our tools to support, thus establishing a framework that directs our work on technical developments.

One major inhibitor of knowledge sharing is employees' fear that by sharing their knowledge, they will turn it into a common good and thus lose their expert power and distinctiveness compared to others [8]. By increasing the visibility of the individuals' expertise, organizations can counteract the feeling of losing expert power through the sharing of knowledge. We identify this as Factor 1. Receiving organizational recognition, positive feedback on the knowledge shared, or feedback on how the knowledge being shared has helped colleagues or the company, often improves one's knowledge sharing self-efficacy [26]. This individual's self-perception of competency, credibility, and confidence within organizational contexts, also known as organization-based self-esteem [18], increases the likelihood that the individual will share his/her knowledge with others (see also Factor 9).

According to Hall [9], people are more willing to share their knowledge if they believe that doing so is useful, i.e., if they feel that their act of sharing knowledge will be appreciated by the community and that their knowledge will actually be beneficial for the community members. This feeling can be induced by providing individuals with feedback about the usage of the knowledge they imparted with the organization, so that they can have continuous awareness of their contribution to the shared knowledge. We refer to this as Factor 2.

Related to the previous issue, low awareness of the value that the knowledge possessed by an individual could have for others, is also cited as one of inhibitors for

knowledge sharing. This issue is marked as Factor 3 in our framework. This awareness could be raised by having virtual message boards where everyone can post the kinds of knowledge he/she might need, so that people who possess organizationally relevant knowledge easily recognize that their knowledge is needed and would be appreciated by others. In addition, by annotating these posts with the topics specific to the knowledge domain, the task of identifying relevant knowledge sources (either knowledge objects or people) can be significantly automated (e.g., in the manner done by Aadwark, http://vark.com/).

Trust is often seen as a necessary precondition for knowledge sharing. This quintessential element of organizational culture refers to employees' trust that others do not misuse their knowledge, as well as trust that the knowledge being shared is accurate and credible. The feeling of trust in the quality of content can be improved by encouraging employees to comment upon and/or rate knowledge objects they consumed. In other words, validation of content is done by the community. We refer to this practice as Factor 4. It would enable others to make more informed decisions when choosing knowledge objects. Additionally, it can invoke positive competitiveness in individuals, motivating them to put more effort in externalizing knowledge, so that their contribution is higher rated. It has been shown [25] that the consumption of shared knowledge, influences knowledge donating in a positive sense – the more shared knowledge a person makes use of, the more he or she is willing to also donate knowledge to others. Therefore, by increasing trust in the knowledge being shared and thus boosting its usage, an organization implicitly makes a positive impact on knowledge "donation" as well.

The feeling of trust among the members of a community often results from shared vision [24] (e.g., common goals) and shared language [7] (e.g., similar jargon and terminology). Accordingly, knowledge sharing can be enhanced through *emergent domain vocabularies* – domain vocabularies initially defined by the organization, but also evolve to accommodate the terminology used by the given community (e.g., a project team). This is Factor 5 in our framework and can be technically supported through approaches for merging domain ontologies and collaborative tags [23].

Studies have found that organizational attitudes including job satisfaction and organizational commitment also foster knowledge sharing [6]. In particular, affective commitment, which is related to an individual's identification and involvement with the organization, is found to be especially relevant for knowledge sharing [25]. Harmonization of personal and organizational goals (Factor 6) can lead to higher affective commitment, and thus positively influence employees' knowledge sharing attitudes and activities.

It is also important for an organization to explicitly state its expectations and norms regarding knowledge sharing activities as well as to link knowledge sharing to company goals and values [15]. We recognize such an approach as Factor 7. This is particularly important as it was shown (e.g., in [11]) that the more time and effort employees perceive as necessary to codify knowledge in order to share it, the less likely they are to engage in knowledge sharing activities. The organization's expectations regarding knowledge sharing activities are sometimes further emphasized by considering the employees' participation in knowledge sharing activities as a criterion of their performance evaluations (Factor 8). Hence, employees are expected to document valuable knowledge, share it, as well as use others' knowledge; all of which to be considered part of their performance evaluation. This kind of incentive targets

employees' extrinsic motivation. However, the organization can also target intrinsic motivation by stimulating perceived competence (i.e., the feeling of being competent enough to do a certain task), perceived autonomy and relatedness (i.e., the feeling of belonging and being connected with others) [20]. We refer to this practice of stimulating intrinsic motivation as Factor 9.

Having identified some important factors that affect knowledge sharing within an organization, in the following sections, we introduce concrete software solutions (services and ontologies) that we are developing to address some of the challenges these factors impose.

3   Services for Individual and Organizational Learning

This section introduces two services that, built on the underlying ontologies (described in Sect. 4), support knowledge sharing activities within an organization. By providing a ubiquitous and seamless sharing platform (i.e. facilitating the technical factors), the Personal Learning and Knowledge Management and Organizational Learning and Knowledge Management services, respectively aim at stimulating individual and organizational factors that affect successful sharing of knowledge in workplace environments. A summary of these factors can be seen in Table 1.

Table 1. Factors affecting knowledge sharing supported by our proposed software solutions

Factor	Description	Nature (incentive/inhibitor)	How this factor is addressed with the proposed software solutions
1	Fear of losing "expert power"	inhibitor	PLKM – visibility levels
2	Awareness of utility of the shared knowledge	incentive	PLKM - Feedback forms, OLKM - emerging vocabularies/ organzational goals
3	Low awareness of the value of one's knowledge for others	inhibitor	PLKM - sharing problems and requests for help and/or advice
4	Misuse of the shared knowledge	inhibitor	PLKM – quality of the shared knowledge
5	Having a shared vision and language	incentive	OLKM – adding collaborative tags to domain ontologies
6	Job satisfaction/ organizational commitment	incentive	OLKM and PLKM – Harmonization of personal and organizational goals
7	Organizational expectations and norms on knowledge sharing	incentive	OLKM - emerging vocabularies/ organizational goals
8	Individuals' extrinsic motivation	incentive	OLKM - emerging vocabularies/ organizational goals, knowledge profiles (initially defined via OLKM), represented in feedback forms (provided by PLKM)
9	Individuals' intrinsic motivation	incentive	PLKM – feedback regarding shared knowledge and sharing activities

3.1   Personal Learning and Knowledge Management (PLKM)

The Personal Learning and Knowledge Management (PLKM) service provides an environment for individuals where they can manage cycles of their learning process within their daily work activities in an organization. Specifically, they can create and share their learning goals; participate in learning and knowledge building activities to achieve these goals; share and document about their learning experiences within accomplished activities, thus contributing to the collective knowledge in their organization; and further refine and nurture their personal learning goals. It is important to notice that PLKM is a ubiquitous software service that can be invoked from any Web-based application. It aggregates individuals' distributed data, scattered in different systems by leveraging the Linked Data principles [2] and our ontologies (Sect. 4).

Managing Personal Learning Goals. A learning process is typically initiated by allowing individuals to define their personal learning goals, harmonized with the goals of the organization they belong to. Both personal and organizational learning goals are represented as sets of competences, and modeled via the Competence ontology (Sect. 4). Considering that defining a commonly accepted characterization of the term "competence" has been subject of much debate within the research community [21], here we briefly mention that within the scope of this research competence is considered to be an individual's skill related to a certain domain topic (e.g. being able to design a car seat using the CATIA software), and leave the rest of this discussion out of the scope of this paper. Following this definition, we initially relied upon the updated version of Bloom's taxonomy [3], but are open to its further modifications based on the specific needs and requirements of the organization, and the context in which it has to be used. Domain topics describe the domain in-use represented via the respective domain ontology (Sect. 4). Contrary to conventional competence-based approaches (e.g. [5]), the personal learning goals are not limited to a set of predefined organizational goals; they are dynamic, can continuously evolve and change during knowledge processes. To further support harmonization of individual and organizational goals, and thus address Factor 6, this module of PLKM allows individuals to define their goals based not only on their personal goals, but to browse and select from the available learning goals in the organization, reflecting organizational expectations/goals and the learning goals of their colleagues. For instance, individuals may want to gain certain competences to be able to better perform the tasks they are responsible for within a project (based on their organizational roles), or they may wish to acquire those competences that would make them eligible for a certain promotion (organizational expectations), or they want to achieve a set of competences that a competent co-worker has. Further, individuals have an option to track their progress with respect to the defined learning goals (Fig. 1).

Let's Share! – Engaging in Knowledge Building and Sharing Activities. Having defined their personal learning goals, individuals engage in learning and knowledge building activities toward achieving their goals. PLKM supports individuals in picking the proper activities by recommending them a set of activities, along with relevant recommended knowledge objects to perform those activities. Those recommendations are based on a set of contextual criteria like an individual's profile and usage behavior and experiences of previous learners in achieving similar goals. This functionality of

PLKM is out of the scope of this paper and we do not get into details of how this recommendation is performed and represented to individuals.

Learning and knowledge building activities can happen in different systems and applications that individuals interact with during their daily work activities. Utilizing social-bookmarking approaches, the Let's Share! module of PLKM provides individuals with an easy-to-use sharing tool which is easily accessible from diverse applications users interact with. Being ubiquitously present and available, individuals use Let's Share! whenever they intend to document their learning efforts and also to share their learning experiences and the knowledge gained or produced. Additionally, Let's Share! allows users to explicitly define the visibility level of the knowledge being shared, be it learning goals, activities or experiences, thus addressing Factor 1.
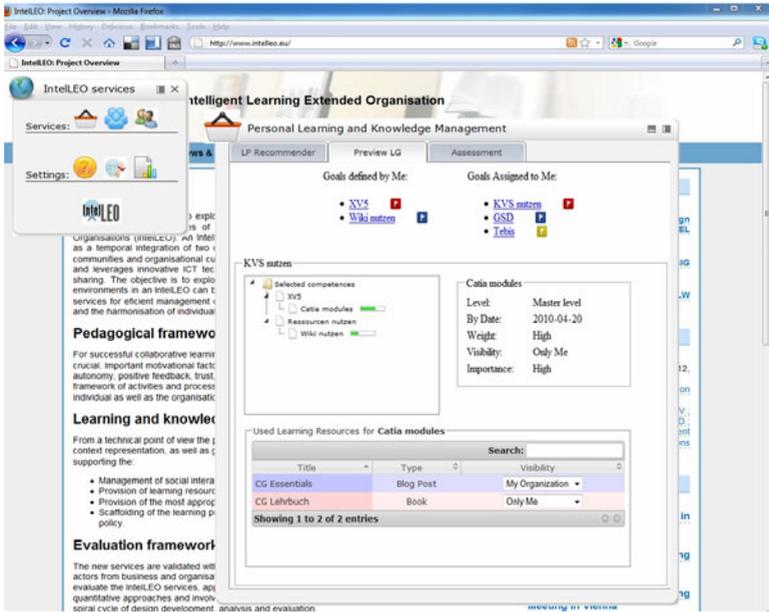

Fig. 1. A screenshot of PLKM that allows for individual progress tracking

On the other hand, Let's Share! also enables users to get notified on the usage of their shared knowledge by providing individuals with (periodic) visual indicators illustrating the quantity and quality (e.g. average 'crowd's opinion' on a shared knowledge item) of the knowledge that they have shared and, the shared knowledge that they have used. Addressing Factors 2 and 4, this utility of the PLKM leads to further motivating individuals in sharing their knowledge and thus, contributing to the collective knowledge of the organization.

3.2 Organizational Learning and Knowledge Management (OLKM)

The OLKM service establishes the framework where organizational goals and norms are reflected. The two main modules of this service are discussed in the following.

Managing Organizational Learning Goals. By allowing for the definition of organizational goals, OLKM builds the structure around which individuals can define their personal learning goals (addressing Factor 6 together with PLKM). In addition to organizational goals explicitly defined by managers in terms of competences (Sect. 3.1), this module of OLKM allows for the discovery of emerging learning goals which can be learned from personal learning goals defined and shared by individuals and harmonized with organizational goals. If some personal goals are frequently being defined by members of an organization, the managers might consider them as 'emerging' organizational goals. As can be seen, organizational goals are also dynamic and can evolve via the contributions of the community members.

Applying Organizational Rules and Expectations. OLKM also provides managers with tools where they can set organizational rules and configurations such as visibility of goals or learning activities, or rules applied for achieving certain promotions. Such regulations further affect the way individuals conduct their learning processes within the organization, intensifying the harmonization of their personal goals with organizational goals and expectations. This module of OLKM allows managers to provide individuals, who had shared their personal learning goals, with feedback on the above mentioned "emerging" organizational goals, making this utility of OLKM three-folded: i) by providing feedback to individuals on the usage of their knowledge sharing activities, it supports Factor 2, ii) it makes it explicit to employees that their knowledge sharing activities are recognized and valued by the organization, and thus worth devoting time and energy (Factor 7) and iii) it targets individuals' intrinsic motivation for knowledge sharing by giving them the feeling of being competent in contributing to the organization's goals and objectives (Factor 9).

The same process with the individual-organizational goals happens when individuals comment on and annotate their shared knowledge. Domain vocabularies of an organization are initially defined by the managers-in-charge, via this module of OLKM (and modeled via domain ontologies). However, there might be some terminologies among the employees which are not initially modeled in the organization's domain ontologies, but frequently reflected in the annotations that individuals use to comment on or tag different shared knowledge objects or activities. Similar to frequently defined personal learning goals, managers also get notified about these collaborative tags via this component and decide whether to add them to the existing vocabulary of the organization, thus supporting Factors 2, 5, 7 and 9. Here, we are using an approach to evolving ontologies based on tag clouds [23].

Additionally, this component provides organizational managers with a tool where they can create knowledge sharing profiles (e.g. ranging from 'total consumer' to 'total donator'), which are used in accordance with visual feedback indicators already discussed in PLKM. Based on individuals' level of participation in knowledge sharing activities, captured and modeled via the respective underlying ontologies, e.g. User model, Workflow and Competence ontologies (see Sect. 4), they will receive (periodic) notifications of their knowledge sharing profiles. These notifications are represented by the Let's Share! module in PLKM, while the initial configuration of the profiles is set through this module of OLKM (thus, supporting Factor 6). Such type of feedback can also, intrinsically, motivate individuals to contribute to knowledge sharing activities (Factor 9).

We explained that PLKM allows users to have control over their shared data and set the visibility level of their sharing activities at the individual level. However, each organization might have certain rules and policies in terms of sharing organizational knowledge. To address this issue, OLKM enables managers to set access rights for the knowledge being shared, e.g. prohibiting sharing of certain types of activities or knowledge objects used in the context of a certain organizational objective. Thus, this module of OLKM assures that individuals' knowledge sharing process is compliant with the organization's culture, rules and norms, leading to higher levels of organizational commitment (supporting Factor 6).

4   Ontologies for Knowledge Sharing

The services presented in the previous section rely on a set of ontologies that provides a common model for data representation and exchange. Since we have developed this set of ontologies within the IntelLEO project (http://intelleo.eu/), we named them IntelLEO ontologies and use this term to refer to them throughout the paper.

4.1   Ontologies for Knowledge Sharing

IntelLEO ontologies are relevant for the presented services as they enable formal representation, storage and seamless exchange of data about:

- individuals' interactions with different and often heterogeneous systems, tools and services they use in their daily work and learning activities; that is, the ontologies serve as a common, machine-interpretable, high-level interaction data model;

- individual's learning experiences (i.e., learning activities and their context), knowledge being shared as well as different kinds of annotations (tags, comments, ratings and the like) that capture either personal or community reflections on the content/knowledge being shared;

- personal learning goals, on one hand, and organizational goals and expectations, on the other.

In addition, the flexibility offered by ontologies as a knowledge representation technique allows for seamless integration of individual knowledge into the collective knowledge of the organization. In particular, one of the main advantages that ontologies offer is the easy integration of knowledge from different, often dispersed sources [2]. Hence, they are an excellent means for integrating individuals' knowledge into shared, organizational knowledge.

As discussed in Sect. 2, previous research in the knowledge sharing domain has shown that both employees and managers can benefit from feedback about knowledge building and sharing activities within the organization. The structure and semantics that ontologies add to the captured and stored interaction data provide an excellent basis for the creation of such feedback. Hence, PLKM and OLKM services leverage this feature of ontologies to offer individuals and managers with relevant feedback and thus further stimulate knowledge sharing activities.

Finally, domain-specific ontologies can be used to annotate semantically different kinds of knowledge being shared, undertaken or planned learning activities, content that was used or produced. The advantage of semantic annotation (i.e., annotation using concepts from an appropriate, topic-specific ontology) over the popular tag-based annotations is that ontology concepts have unambiguously defined semantic accessible to both humans and machines. It also allows for semantic interlinking (i.e., connecting based on meaning) of diverse kinds of components of a learning process (e.g., activities, content, knowledge, people). Thus, by leveraging semantic annotations, advanced search, discovery and recommendation services can be provided to end users.

## 4.2   IntelLEO Ontologies – A Brief Overview

IntelLEO ontologies have been developed through a combined top-down (review of existing work in the field) and bottom-up (requirements elicitation) approach. Since a common and even recommended practice in ontology engineering is to reuse existing ontologies whenever possible (instead of re-inventing new ones) [2], when designing the IntelLEO ontologies we heavily relied on the ontologies already available and in use. Specifically, we leveraged widely accepted and used ontologies for modeling people and online communities (FOAF, http://xmlns.com/foaf/0.1 and SIOC, http://rdfs.org/sioc/spec/), ontologies for content annotation (DC, http://purl.org/dc-/terms/ and CommonTag, http://www.common-tag.org/), as well as some of the ontologies of the LOCO framework (http://jelenajovanovic.net/LOCO-Analyst-/loco.html) for modeling characteristics of learning situations. Also in accordance with ontology engineering best practices, all the IntelLEO ontologies are designed with modularity and flexibility in mind so that they can be easily reused and extended. Here we present just some snippets of these ontologies aimed at illustrating how they support the PLKM and OLKM services.

a)   b)
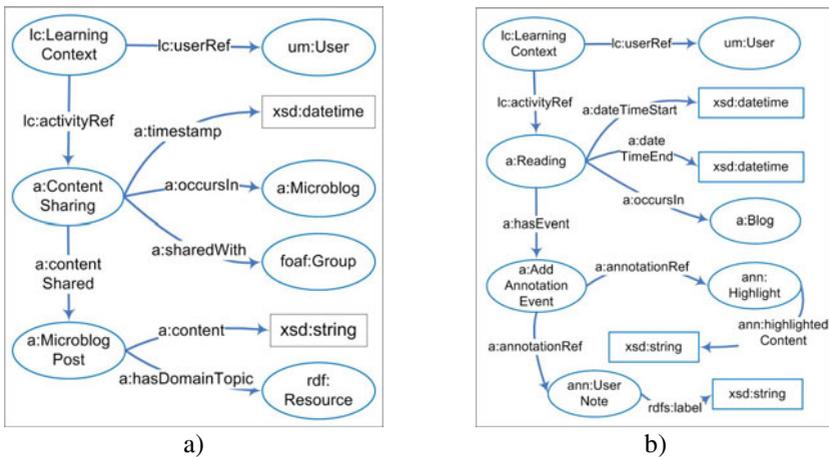
Fig. 2. Using ontologies to represent the context of (a) content sharing activity; (b) content annotation event

Fig. 2a[1] illustrates how we represent data about an individual's content sharing activity. This activity, as any other learning activity, occurs within a specific learning context, where learning context is defined as a specific learning situation characterized by the learning activity that was performed, the learning content that was used and/or produced, and the learner(s) involved [10]. In the particular case depicted in Fig. 2a, learning context characterizes a situation where an individual shared a microblog post with a group (e.g., his team-mates); the post is annotated with one or more domain topics (i.e., topic from appropriate domain ontologies). The time and the online environment where the sharing activity occurred are captured as well. Another example (Fig. 2b) illustrates how we use ontologies to represent data about content annotation (which is again a kind of knowledge sharing). In this case, learning context characterizes a situation when an individual, while reading a blog post, highlights certain parts and adds his comments to it.

Finally, Fig. 3 illustrates how individual and organizational goals are represented and how they relate to each other. In the upper part of the figure is a representation of a task, which is a part of the project an individual works on. The task has its prerequisites expressed in terms of the required competence and the required level of that competence. In the bottom part of the figure is an individual's learning goal represented through target competence and target level of that competence. This goal stems from the missing prerequisites for accomplishing the task and can be either self-defined (um:PersonalLearningGoal) or set by a manager (um:AssignedLearningGoal). Project, competence and competence level are "in the middle", linking the individual and organizational goals/perspectives.
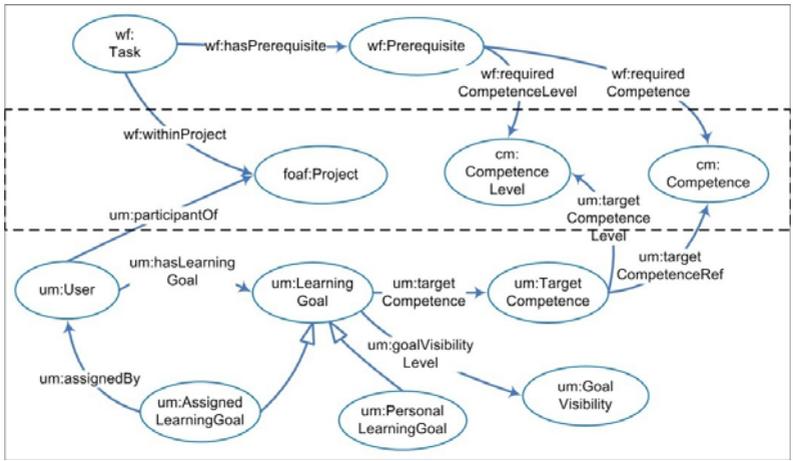
Fig. 3. Representation of personal and organizational goals using concepts and properties from the User Model (um), Competence (cm) and Workflow (wf) ontologies

---

[1] To avoid the clutter, we do not present all the concepts and properties that are used for describing elements of a learning context. The same applies for the other two figures.

5   Case Study

We have conducted an evaluation of the early prototypes of our services within three very different application cases. In this section, however, due to page limits, we introduce only one of these application cases. The aim of this section is to express how our proposed services can be used to address contextual factors affecting knowledge building and sharing activities inside real-life business cases, thus here we demonstrate these services assuming their full functionalities. More thorough evaluations, based on more advanced functionalities of the services, will be conducted by the end of July 2010.

Enterprise A[2] is a large enterprise in the automotive industry. Within this organization, a small business unit needs to implement an innovative approach to collaborative learning and knowledge building processes.. The dynamic and competitive nature of this enterprise makes managing the knowledge process very challenging, especially for its newcomer employees. As there is no institutional education program for the type of job undertaken by the business unit, the most important source of expert knowledge are peers and the knowledge pool generated by related projects. Newcomers have to familiarize themselves with organizational policies and administrative regulations, cautiously create their learning goals, in line with organizational goals, pursue learning and knowledge building activities and continuously refine and adjust their learning goals. On the other hand, more experienced employees are less concerned about getting started with creating and pursuing their learning goals. They are already familiar with the big picture of how things happen in Enterprise A, and involved in rather time-constrained projects. What matters more for these individuals is to be able to find the "how-to"s for different problems that they face, as efficiently as possible. Typical in design environments, there is no preset solution for every problem, instead, such "how-to"s are mostly based upon other individuals' experiences. Thus, having a rich set of "how-to"s within the enterprise requires all employees to actively participate in sharing their knowledge and experiences with the rest of the enterprise. A major concern in contributing to the collective knowledge of the organization, however, is the motivation of employees to spend their most scarce resource (i.e. time) on codifying their experiences to be shared (currently they are only shared via informal, face-to face meetings). To this end, gaining a superior reputation among other colleagues and even managers, is an important factor that can motivate individuals within the competitive environment of Enterprise A to expose their expertise, compensating for the time-consuming task of codifying the conducted activity or experience into something shareable. In this way, by sharing their experience, the individuals would not only contribute to the collective knowledge of the organization, but they would have a chance to improve their skill profiles to "problem-solvers", while making their expertise visible among their peers and the management.

IPR issues are also of high concern for both groups of individuals. Due to the very competitive nature of Enterprise A, all the knowledge within the organization, from organizational objectives to shared experiences of individuals, is strictly protected and distributable only if compatible with organization's complicated privacy policies. This makes most of the employees preferring to avoid the challenging task of sharing

---

[2] Due to privacy and IPR rights, at the moment we refer to this enterprise as Enterprise A.

knowledge when facing the trade-off between getting involved with verifying organizational policies and gaining some potential reputations within the enterprise.

The project involved five employees with different experience levels and from different sub-departments in the requirements elicitation via explorative interviews and focus groups, and two project champions in the evaluation of early prototypes. By involving those employees in this stage of evaluation, we identified the following situations in which the presented services were considered important and useful for the organization under study: The personal learning goal management module of the PLKM software allowed newcomers of Enterprise A to easily initiate and attain their learning and knowledge sharing processes. As this module is a light-weight semantic-enabled widget, it can be embedded in any web-based application that individuals use in their daily work activities, and thus does not put the burden of "learning to work with yet another tool" on them. By means of this module, the newcomers had access to the set of organizational goals and could see a full description on each goal reflecting organizational norms and expectations about it (N.B. it is assumed that the initial set of organizational objectives are previously added to the system via the OLKM software, by a manager of the enterprise). Here, users also see the prerequisite competences for achieving each goal and can accordingly adjust their personal learning goals.

It was also noted that, to keep pace with the dynamic changes of the business unit's tasks and expertise, the more experienced employees can individually share new learning goals and competences via the Let's Share! module. This allows for a continual adaption and advancement of the departments' learning goals and competence development. Let's Share! of PLKM along with OLKM made knowledge sharing become a very handy activity for the employees of Enterprise A. First of all, OLKM aids with clarifying the access-rights applying to the knowledge object/activity to be shared: the visibility levels that individuals can set for the knowledge object /activity that they want to share, is already filtered based on the access-rights set by the managers via OLKM, thus individuals merely set the visibility level that they desired to assign to this knowledge and did not have to be concerned about violating any organizational privacy rights. Second, this module is context-aware[3], thus it (automatically) gathers all the contextual information about the knowledge object or activity to be shared, e.g. the personal learning goal (and the respectively harmonized-with organizational objective) plus the project/task this knowledge has been used within and the competence-profile of the user sharing it (of course, if the user wishes to share his/her profile). Thus it makes the time-consuming task of codifying the knowledge as easy as bookmarking a web-resource. Only a small number of employees produce external web-resources, but the documentation and externalization of knowledge and experiences is mainly based on the internal wiki-systems as well as the organization's Intranet. Thus, our services help to share internal resources that are relevant for colleagues. Finally, the feedback provided by Let's Share! offers individuals with visual indicators on i) how good knowledge-consumers or donators they are and the status of their "skill-profile" based on the criteria set by managers via the OLKM component, and ii) comments and annotations on their shared knowledge, reflecting how others think about their knowledge sharing activities, thus affecting individuals' intrinsic motivation to further participate in knowledge sharing activities.

---

[3] Due to the page limit, we do not discuss the concept of "context", or how it is captured here.

6   Related Work

Improving knowledge sharing within an organization has been the subject of several research efforts recently, both from the technological and organizational standpoints. The challenge is to ensure that knowledge sharing is provided within an organizational context during everyday working process and in working environment.

The APOSDLE EU project aims at enhancing knowledge workers' productivity by supporting informal self-directed work-integrated learning in the context of their everyday work processes [13]. The applied knowledge creation and sharing approach was based on the reuse of the existing (organizational) knowledge objects (KOs). Additionally, KOs created during everyday work processes could be tagged, stored and made available for later (re-)use by other employees. Collaboration among employees is supported through tools allowing for communication and sharing of the documents being discussed and marking relevant parts within these documents. It also offers a space for joint creation and annotation of documents that support the explanation and further discussion of the concepts being examined.

The TENCompetence Foundation, established to sustain the results of the TENCompetence EU project, aims to support and foster lifelong learning through an integrated open source software infrastructure [5]. This infrastructure provides users with functionalities for creation, storage, search, retrieval, reuse, sharing and quality rating of knowledge resources. A particularly interesting tool integrated into this infrastructure is GroupMe! [1]. It combines Web 2.0 and Semantic Web technologies to provide a personalized content management in a group (social networking) context. By leveraging Semantic Web technologies, it also allows for integration and sharing of resources relevant for a group of users.

Within the ACTIVE EU project, semantic technologies are used for addressing three particular requirements of knowledge workers: the need to share information easily and effectively; the need to prioritize information relevant to the current task; and the need to reuse and share information [27]. Specifically, the approach applied in ACTIVE is to combine formal and informal knowledge, i.e. it investigates how to provide easier sharing of information through combining the ease-of-use of folksonomies with the richness of formal ontologies.

The MATURE EU project examines how: informal knowledge is developed in organizations, networks and communities of practice to develop and support the exchange of knowledge with support of social software tools [4]. MATURE Knowledge Services are composite software services concerned with knowledge entities (people, content and semantic structures). They enable people to add or improve knowledge contained in knowledge entities or to discover knowledge based on the available knowledge entities and their relationships.

While all the described projects target knowledge sharing within organizational settings, most of their efforts are put on solving problems of sharing information easily and effectively, and providing tools for knowledge creation, storage, search, retrieval, reuse and sharing. However, less attention is paid to the problem of motivating users for knowledge sharing. In our work we try to go a step further by analyzing incentives and disincentives for knowledge sharing within organizations and propose appropriate software solutions to support it.

7   Conclusion

As our initial evaluation through the case study demonstrates there is a positive attitude towards the proposed software solution (Sect. 3) for harmonization of personal and organizational learning by levering the framework for individual and organizational incentives introduced in Sect. 2 and ontologies introduced in Sect. 4. While these results are encouraging, it is the major direction of our future work to provide more rigorous evaluation of the overall approach. There have been employees involved in the current user studies, but the number is not very large as it is difficult to get access to those employees. So, in general, we want to increase the number of participants involved in the studied enterprise. In that evaluation, it will be our major goal to investigate how our software solution supports the perceived value of the factors outlined in Sect. 2. While qualitative methods like initial questionnaires including open questions and follow-up semi-structured interviews will help to reveal important details about individual, organizational and technical factors that influence the acceptance and usage of the developed services, it is a challenging task to identify data collection methods which will allow for collecting data about more objective variables. In the first iteration planned for the laboratory setting in the studied enterprise A, we plan to ask their employees to complete a few tasks, and then analyze logs produced in completing those tasks, which will help to evaluate the learnability and usability of the services, revealing problems, design ideas, and design gaps.. Moreover, it is our plan to conduct similar evaluations in an SME, university and professional certification organizations. One important goal will be to compare how different organizational cultures influence knowledge sharing. Our final objective is to evaluate how the proposed framework can be extended to allow for knowledge sharing in an inter-organizational context.

From the semantic technologies perspective, it is clear that many details are not provided primarily due to the space constraint of this paper. In our future publications, we are going to report on these issues and provide formalization of our approach. Moreover, evaluation of the used semantic technologies from both the standard information retrieval and usability perspectives will be in the core of our work.

References

1. Abel, F., Frank, M., Henze, N., Krause, D., Plappert, D., Siehndel, P.: GroupMe! - Where Semantic Web meets Web 2.0. In: Proc. of 6th Int'l. Semantic Web Conf., pp. 871–878 (2007)
2. Allemang, D., Hendler, J.: Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL. Morgan Kaufmann, San Francisco (2008)
3. Anderson, L.W., Krathwohl, D.R., et al.: A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Allyn & Bacon, Boston (2000)

4. Attwell, G., Barnes, S.A., Bimrose, J., Brown, A.: Maturing Learning: Mashup Personal Learning Environments. In: Proc. of the First International Workshop on Mashup Personal Learning Environments, Maastricht, The Netherlands (2008)
5. Berlanga, A.J., Sloep, P., Kester, L., Brouns, F., Van Rosmalen, P., Koper, R.: Ad hoc transient communities: towards fostering knowledge sharing in learning networks. International Journal of Learning Technology 3(4), 443–458 (2008)
6. de Vries, R.E., van den Hooff, B., de Ridder, J.A.: Explaining knowledge sharing: The role of team communication styles, job satisfaction, and performance beliefs. Communication Research 33(2), 115–135 (2006)
7. Dougherty, D.: Interpretive barriers to successful product innovation in large firms. Organization Science 3, 179–202 (1992)
8. Gupta, A.K., Govindarajan, V.: Knowledge management's social dimension: Lessons from Nucor Steel. Management Review 42(1), 71–80 (2000)
9. Hall, H.: Input-friendliness: Motivating knowledge sharing across intranets. Journal of Information Science 27(3), 139–146 (2001)
10. Jovanovic, J., Gašević, D., Brooks, C., Devedžic, V., Hatala, M., Eap, T., Richards, G.: Using Semantic Web Technologies for the Analysis of Learning Content. IEEE Internet Computing 11(5), 16–25 (2007)
11. Kankanhalli, A., Tan, B.C.Y., Wei, K.K.: Contributing knowledge to electronic knowledge repositories: An empirical investigation. MIS Quarterly 29(1), 113–143 (2005)
12. Lieb, S.: Principles of Adult Learning, VISION (1991),
    http://honolulu.hawaii.edu/intranet/committees/FacDevCom/
    guidebk/teachtip/adults-2.htm
13. Lindstaedt, S., Mayer, H.: A Storyboard of the APOSDLE Vision. In: Nejdl, W., Tochtermann, K. (eds.) EC-TEL 2006. LNCS, vol. 4227, pp. 628–633. Springer, Heidelberg (2006)
14. Littlejohn, A., Margaryan, A, and Milligan, C.: Charting collective knowledge: Supporting self-regulated learning in the workplace. In. Proc. of the 9th IEEE International Conference on Advanced Learning Technologies, 208-212. (2009)
15. Mcdermott, R., O'Dell, C.: Overcoming cultural barriers to sharing knowledge. Journal of Knowledge Management 5(1), 76-85 (2001)
16. Mikroyannidis, A.: Toward a Social Semantic Web. Computer 40(11), 113–115 (2007)
17. Pata, K.: Revising the framework of knowledge ecologies: how activity patterns define learning spaces? In: Educational Social Software for Context-Aware Learning: Collaborative Methods & Human Interaction, pp. 241–267. IGI, Hershey (2009)
18. Pierce, J.L., Gardner, D.G.: Self-esteem within the work and organizational context: A review of the organization-based self-esteem literature. J. of Management 30, 591–622 (2004)
19. Riege, A.: Three-dozen knowledge-sharing barriers managers must consider. Journal of Knowledge Management 9(3), 18–35 (2005)
20. Ryan, R.M., Deci, E.L.: Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist 55, 68–78 (2000)
21. Sampson, D., Fytros, D.: Competence Models in Technology-enhanced Competence-based Learning. In: International Handbook on Information Technologies for Education and Training, 2nd edn. Springer, Heidelberg (2008)
22. Siemens, G.: Connectivism: Learning as Network-Creation (2005),
    http://www.astd.org/LC/2005/1105_seimens.htm

23. Torniai, C., Jovanović, J., Bateman, S., Gašević, D., Hatala, M.: Leveraging Folksonomies for Ontology Evolution in E-learning Environments. In: Proc. of the 2nd IEEE International Conference on Semantic Computing, Santa Clara, CA, USA, pp. 206–215 (2008)
24. Tsai, W., Ghoshal, S.: Social capital and value creation: The role of intrafirm networks. Academy of Management Journal 41, 464–476 (1998)
25. van den Hooff, B., de Ridder, J.A.: Knowledge sharing in context: the influence of organizational commitment, communication climate and CMC use on knowledge sharing. Journal of Knowledge Management 8(6), 117–130 (2004)
26. Wang, S., Noe, R.A.: Knowledge sharing: A review and directions for future research. Human Resource Management Review 20(2), 115–131 (2010)
27. Warren, P., Kings, N., Thurlow, I., et al.: Improving knowledge worker productivity – the ACTIVE integrated approach. BT Technology Journal 26(2) (2009)