PKS: An Ontology-based Learning Construct for Lifelong Learners

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ABSTRACT

This paper addresses adult lifelong learners, i.e., persons interested in learning or compelled to learn during their working life but not able to, or not interested in participating in formal learning. These learners are motivated and self-aware enough to self-direct their learning, are presumed to be novices with respect to the needed knowledge and have a limited technological uptake. This paper will outline their main differences from regular learners, in particular, for the use of social media to improve learning skills. The reference pedagogical model is andragogy. A Service-Oriented Architecture, named Personal Knowledge Space (PKS), is proposed to support our lifelong learners in selecting, organizing, and retrieving information; in streamlining interaction processes among learners, services and resources and finally in empowering control and trust of personal relationships born during the learning processes. The PKS is mainly based on the exploitation of semantic tools (ontologies) and web services. Use cases describing the PKS architecture and one scenario of PKS use are presented.

Keywords

Informal learning, Andragogy, Semantic web, Service oriented architecture, Professional development

Introduction

This paper focuses on adult lifelong learners (LLLs), i.e., persons interested/compelled in learning during their professional life but not able/interested to learn in educational institutions. Their specific learning characteristics can be summarized as follows:

- the learning process is intentional and self-motivated;
- learning pace and time are in charge of the learner;
- learning objectives are chosen by the learners, usually refer to knowledge domains not yet mastered and are mainly related to building usable knowledge relevant to professional purposes;
- the attainment of the learning objectives doesn’t lead to a certification but is appraised by the learners themselves;
- knowledge and learning resources for the learning process are searched for by the learner;
- the learner doesn’t ask educational institutions to provide structured support, but may want to consult learning resources offered by institutions (i.e., handbooks, courseware, …).

Therefore, the learning process of our LLLs may utilize formal, non-formal and informal learning resources for professional development. They would require the professional to interact with experts or peers in the targeted domains. This learning process encompasses most of the ten attributes of informal learning described in Boekaerts & Minnaert (1999). Motivation and ability to self-regulate the learning process, are recognizable features in many professionals.

Anderson (2005) and Klamma et al. (2007) argue that web 2.0 (Oreilly, 2007) and social software may support distance and lifelong learning. Broadly speaking, social software applications are “communication tools and interactive tools often based on the Internet” (“Social software,” n.d.). Web 2.0 technologies may be used to support the development of LLL skills (Dunlap & Lowenthal, 2011). However, they require the learner to master technological skills. Our LLLs might not have such skills since in most cases they are “digital immigrants” (Prensky, 2001). They might be exposed to information overload (Sweller, 1988) and to the syndrome of “being lost in social space” (Dron & Anderson, 2009).

To enlighten the characters of our target LLLs, let us mention some characters of the regular students within educational institutions. They are usually “digital natives” (Prensky, 2001), but frequently lack the competence to exploit web 2.0 technologies for learning purposes, and the ability to self-regulating their learning. Training is needed to fully exploit the learning power of these technologies.
Educational institutions are committed to offer their students tools to assist them in carrying out informal learning in support of formal learning (Dron & Anderson, 2009). For this purpose, Personal Learning Environments (PLEs) seem to be a promising approach. The current PLE implementation within educational institutions (Dabbagh & Kitsantas, 2012; Klamka et al., 2007; Pettenati et al., 2007) and professional organizations (Cheng et al., 2011; Scherp et al., 2009) seems to be characterized as follows:

- the knowledge domain and its specific language are usually defined by a teacher or a tutor;
- the students define their personal profile, usually only in social terms;
- the learning needs are defined with the teacher’s support;
- after the profile’s definition, the students begin to shape their PLE;
- the learning objectives are defined by the institution/organization, not by the students.

On the contrary, our target LLLs should specify by themselves their learning profiles in terms of domain, objectives and social actors to be found, as well as master the knowledge domain language.

Therefore, our objective is to propose a model architecture able to assist our target LLLs in finding, reordering, classifying, interacting with the proper knowledge resources, and sharing them with other persons having similar requirements. Such an architecture could assist in the birth of some “semiotic social space” (Gee, 2005) able to support a community of learners in the process of sharing and creating knowledge.

The non-homogeneous level of technology uptake has to be taken into account, together with the need of personalizing the learning experiences. This implies a number of relevant issues: proper profiling of the LLL, semantic exploration of the resources available on the web, identification of candidate persons to enter in touch with. Moreover, support for suitable tagging of such resources should be provided.

We would name this architecture “Personal Knowledge Space” (PKS). The research objective of this paper is to demonstrate that such architecture can be implemented by using some of the currently available web 2.0 tools and services.

Related work

We will consider some skills that regular students are trained to learn at educational institutions. These skills refer to the ability of exploiting web 2.0 technologies and self regulating the learning process. In particular, we will consider research relative to the PLE use at educational institutions. The purpose is to identify technology functions able to replace the guidance given by the institution (teachers, tutors, curricula), at least partially. Of course, this survey will be partial because of the richness of the relevant literature.

There are several definitions of PLE. According to Attwell (2007), PLE is not an application but rather a construct describing the use of new technologies for learning. In this paper, we will refer to PLE as a metaphor generating at least two research mainstreams:

- the educational mainstream focuses on pedagogical and instructional issues related to the adoption of PLEs, also within formal contexts (Häkkinen & Hämäläinen, 2011; Pata, 2009). PLE helps learners to take control of their own learning (van Harmelen, 2006).
- the technological mainstream mainly investigates components, tools, or applications suitable for integration into PLEs (Chatti et al., 2009; Drachsler et al., 2009; Wilson et al., 2009). PLE is described as a mash-up application.

As for the educational mainstream, notice that the ability of self regulating the learning process is a fundamental feature of a LLL (Boekaerts, 1999). As shown by psychological research, such ability dynamically changes due to motivation. Motivation is heavily influenced by psychological and social aspects involved in social software use, as clarified by Pereira et al. (2010). Their model fits well with the concept of “semiotic social space” (Gee, 2005) and with the concept of “socio digitization” (Latham & Sassen, 2005).

As for technology, the learner can create her/his own learning mash-up that leverages components and contents generated by learning service providers and other learners around the web. So a PLE may be seen as a learner-centered and learner-designed content aggregation and connections management tool. The focus is on creating knowledge through reification (Wenger et al., 2002).
It can be argued that the features of the available learning environment may enforce motivation or foster disaffection in the development of the learning process. According to Conole (2010) another key issue is that the technology uptake of many potentially effective LLLs is not sufficient to enable them to fully exploit the web 2.0 opportunities. Notice that, as shown by Valtonen et al. (2011), there is no real differences between “digital natives” and “digital immigrants.” Therefore, it seems reasonable to consider such issues as specifications for usability and accessibility of social software.

The educational institutions are committed to offer their students tools to assist them in developing informal learning patterns in support of formal learning. Some proposals related with the concept of PLE are driven by the concern to give students the skills needed to become LLLs. Pettenati et al. (2007) and Dabbagh & Kitsantas (2012) highlight that students need specific training to empower their sense of personal agency.

In our opinion the key point is the intention to train students to become knowledge prosumers (producers and consumers in parallel) able to exploit the interoperability between content and services in a ubiquitous environment. Klamma et al. (2007) highlight the objective of training students to participate in the creation of web 2.0 by developing activities through social software tools and environments. In corporate settings too, some professional organizations aim at exploiting web 2.0 communities to create, organize, share, and utilize enterprise-relevant knowledge (Cheng et al., 2011; Scherp et al., 2009).

On balance, PLEs used within institutional settings seem to have the following limitations:
- the start up of the PLE is proposed and/or guided by the educational institutions (Conole, 2010; Drachsler et al., 2009) and the teacher has to act as tutor or facilitator;
- technological skills are needed to manage the mash-up to integrate different services;
- in the student profile, knowledge needs/objectives are implicitly defined by the curriculum offered by the educational institution.

More limitations and/or disadvantages are presented by Ivanova (2011). The architecture proposed in our work is aimed at reducing or eliminating some of these limitations.

The enabling technologies for PLE rely on the Software-as-a-Service (SaaS) delivery model. In such a model the software owner is separated from the user (Laplante et al., 2003; Turner et al., 2003). In the last decade, the SaaS model has become one of the most common delivery model in several application domains: among them, learning (Learning-as-a-Service or LaaS) and social networks (Social SaaS) are related to our work. The LaaS model (Spaniol et al., 2008) aims at providing learners with the most suitable contents anytime/anywhere according to the SaaS model. Furthermore, the Service Oriented Architecture (SOA) implicit in the SaaS model makes the interoperability of resources easier. Notice that the most popular social networks (e.g., Facebook, LinkedIn, and Google) adopt a SaaS delivery model.

Apparently, interoperability among heterogeneous services, which can be difficult or even impossible to attain when there are different schemas and different names for the same concepts, is not systematically tackled by PLE research. Semantic tools could help overcome this problem. Recent researches suggest exploiting social resources for defining ontology specifications for PLE (Ivanova, 2011; Ivanova & Chatti, 2010). In our view, a viable solution is represented by the Semantic Web (Berners-Lee et al., 2001) and the Social Semantic Web (Torniai et al., 2008), where services and data must have access to structured collections of concepts and relations between concepts (i.e., ontologies), and sets of inference rules. Concepts are usually thought of as sets of objects or individuals whereas rules can be used for automated reasoning (Baader et al., 2003).

Most authors agree that an ontology should be defined in a formal language suitable for automating reasoning. Well known languages are:
- OWL (Motik et al., 2005), based on the Description Logics SHIQ(D) and SHIOQ(D) (Sirin et al, 2007);
- RDF (W3C, 2004), based on multigraphs;

An ontology should be a unique, universally accepted formalization of the domain. This is indeed a strong assumption. However, recent trends show the definition of a large number of ontologies related to many domains.
Several companies and organizations are defining, or have already defined, standard ontologies for specific domains (Bodenreider, 2004; Nayar & Beldona, 2010). We will assume, in the rest of the paper, that it is possible to use standard ontologies for a given domain.

PKS specifications

Since the PKS conceptual model is strictly related to learning and knowledge management, we need to scaffold technical requirements within the suitable pedagogical framework.

Pedagogical model

The PKS is based on social-constructivist learning theories. The main references are constructivism and social-constructivism (Jonassen & Land, 2000; Varisco, 2002). Other theoretical references are networked learning (Blackall, 2005) and connectivism (Siemens, 2004). Within this theoretical frame, the concept of community is central.

The present paper mainly refers to “andragogy” (Knowles, 1990). Even if criticized by some authors (Merriam et al., 2007), it seems that the characters of adult learning require the definition of specific educational frameworks: The learning path must respond as accurately as possible to the needs of the recipient; for learning to be effective adults need to be actively involved in a learning process consistent with her/his specific needs; moreover, learning must take place in a collaborative environment, where learner can interact with other learners or with persons she/he recognizes as experts.

In accordance with this pedagogical model, the PKS would help the learner in:

- selecting, organizing, retrieving information, and reducing the information overload;
- streamlining the interaction processes among learners, services and resources, with benefits on the “lost in social space” phenomenon;
- empowering control and trust of the personal relationships.

PKS technical and functional requirements

Our target LLL is a motivated adult learner, self-aware enough to self direct their own learning process in order to acquire usable knowledge. Such knowledge is frequently multi-domain and to some extent tacit (owned by experts to be identified and/or to be built up through social interaction with peers). The relevant formalized knowledge has also to be identified and collected.

Our target LLL is initially a novice, has a limited technological uptake, and has to deal with documental and human resources (see Figure 1). He has basically three main tasks to fulfill:

1. to retrieve resources from the web space (“Semantic Searching,” Figure 1);
2. to organize and/or classify them, (“Semantic Collaborative Tagging,” Figure 1);
3. to “use” them (“Contacting People” and “Accessing Documents,” Figure 1).

From a knowledge management perspective, the PKS is for the learner a personal environment capable of representing and managing possible states of her/his knowledge within one or more domains of knowledge. Such domains of knowledge represent concepts known and knowable by the learner (Doignon & Falmagne, 1998). Therefore, resource retrieval and resource organization have to be driven by a module devoted to the construction and the dynamic update of the learner profile (“My Profile,” Figure 1). Furthermore, each learner may produce documents to be shared with other learners in the PKS network (“My Docs,” Figure 1). Such documents must be organized and classified.

Due to the large variability of the learners’ characters and requirements and of their knowledge contexts, we propose semantics to allow unambiguous communication among human actors and digital resources. The proper semantic tools are ontologies. Databases and taxonomies do not have the feature of being universally agreed upon. The initial state and parameters of the learner profile should be set up by the learner on the basis of suitable ontologies. While
learning progresses, adaptivity (Brusilovsky, 2001) and personalization of the learner profile are to be managed at a semantic level.

Finally, all the PKS functionalities have to be invoked by means of a friendly user interface built up as an intuitive and easy to use Web page.

*Figure 1. Use case diagram of PKS*
PKS architecture

The PKS architecture consists of one module for each main use case. Each module deploys three basic services: searching for resources; organizing and classifying resources; and “using” resources (contacting people and accessing resources). Furthermore, to support a population of LLLs and to foster the creation of specific communities, PKS has been designed with a SOA adopting a SaaS delivery model. The architecture is depicted in Figure 2. The server is depicted by means of a UML (Unified Modelling Language) (Hunt, 2000) component diagram to make the deployed services evident. The server has also a repository (the “PKS Repository” in Figure 2) containing the profile and all the retrieved resources of each LLL. The client (PKS Desktop) is depicted by means of a workflow diagram using the Business Process Management Notation (BPMN) (White & Miers, 2008) to make evident the activity sequence adopted by the learner for her/his learning process. The client allows the learner to perform the operations represented by the four main use cases. The client has also a “Local Repository” with learner own resources and profile. The learner can synchronize her/his local repository with the PKS repository. Finally, Figure 2 makes evident that the PKS server is interfaced with social software and other web resources (e.g., LinkedIn, Google, repositories, and so on).

A SOA has to be preferred to a peer-to-peer architecture. Indeed, in a P2P architecture resources are only local, even if shared with other users. Therefore, a resource becomes temporary unavailable when the owner is not connected. Furthermore, our target LLL might want to access to her/his resources from different devices in an ubiquitous computing fashion. The SOA solution allows the learner to have access to the same set of resources independently on the device she/he is using. Finally, the SOA is interoperable with other tools.

Use case: “My Profile”

The profile consists of a set of attributes describing a learner; there is one profile for each PKS user. Useful attributes for a basic learner’s profiling can be found in Brusilovsky (2001) and Wilson (2005). Here we consider the following categories coherent with the Europass Model for CV (Karampiperis et al., 2006; CEDEFOP, 2012):
1. Personal information;
2. Desired employment / Occupational field;
3. Work experience;
4. Education and Training;
5. Language(s);
6. Personal skills and competences.

The learner will describe: under category 2, the current field of interest; under category 3, the held competences; under category 4, the certified past knowledge, such as degrees; under category 5, the known languages (to filter the retrieved resources); under category 6, the social networks she/he participates in and the relative accounts, and finally the level of ICT uptake.

The profile has an initial default configuration (Figure 3).

This manner of building up the profile would avoid the risk of inconsistency and ambiguity connected with a completely free bottom-up approach, due to the different language and cultural background of each LLL.

To properly define the profile of the PKS user attains the identity issue. In the context of Knowledge Management this issue has to be dynamically related to the current topic of interest for the PKS user.

To be effective the PKS interface has to assist the learner in self-defining and to specify the present profile in coherence with the profile specifications of the existing social networks he may want to join.

On the basis of the information provided by the learner under categories 2 and 4, the PKS would propose one or more “knowledge contexts”. Those are presented to the learner by means of a tabbed document interface. Tabs allow to visualize separated, different, and contextual interfaces, which only present meaningful information on a particular knowledge context. Each tab is composed by several graphical elements (Figure 4).
The PKS asks the learner to type in a description of the knowledge context and some keywords and then automatically looks up for corresponding ontology(ies) in its repository. If no suitable ontology is available, the learner can import a known ontology, and/or ask the PKS to search for Owl ontologies in Google. If nothing is found, the PKS suggests using WordNet (Miller, 1995). In this case, the learner would use WordNet concepts similar to the original keywords. Next, the PKS presents a tree corresponding to the ontology, or a vocabulary of terms corresponding to WordNet.
After the user has selected meaningful concepts, the PKS will start the search of documental and human resources. This manner of setting the semantic search is again aimed at avoiding the risk of inconsistency and ambiguity. The use case is implemented by the *My Profile* module that provides the following three basic services: *Insert Profile*, *Import Profile*, and *Import Ontology*:

- the *Insert Profile* service consists in guiding the learner step-by-step in inserting a profile according to Europass;
- the *Import Profile* service imports relevant information about the learner from the profiles inserted in her/his accounts at other social software;
- the *Import Ontology* service selects the domain ontologies related to learner’s objectives, interests, previous knowledge, and skills. The PKS proposes the ontologies containing concepts related to the keywords specified in the knowledge context tab interface (Figure 4).

The ontologies here considered are OWL ontologies, which are based on description logics.

**Use case: “Documental Resources”**

Documental resources are documents (in different formats), web sites, multimedia resources and other learning resources available online. This use case is implemented by the *Documental Resource Management* module that provides the following basic services: *Semantic Search*, *Semantic Tagging*, and *Document Access*.

The *Semantic Search* service formulates a query and retrieves a set of instances answering the query, within and outside the PKS. The PKS provides the learner with an interface to navigate the selected ontology and to extract concepts and attributes to be used for internal search. The same concepts and attributes can be used as keywords for external search. In the case of internal search, the selected concepts and attributes are translated in standard SPARQL-DL queries (Sirin & Parsia, 2007) by a PKS procedure and answered by Pellet OWL Reasoner (Sirin, Parsia, & Cuenca, 2007) working inside the PKS server. In the case of external search (semantic/non semantic), the keywords are used to search for more resources by means of popular search engines (e.g., Google) and/or repositories of learning resources (e.g., Merlot, MIT Open Courseware, …). So, external (semantic and non-semantic) search engines are mashed-up.

All the results are presented to the learner in a single interface (Figure 5), allowing to select whatever is deemed useful.

If the retrieved resource comprehends standard metadata, they are automatically parsed and used to classify the resource. The following elements from the DCMI (Dublin Core Metadata Initiative) are parsed: title, subject, description, rights, date, language, rights’ holder, and identifier. This may be the case of a learning resource retrieved from an institutional repository, or an open repository such as Merlot (http://www.merlot.org). If the retrieved resource is not indexed by metadata, the PKS user can tag it by using the concepts and attributes which have generated the semantic query. Moreover, after reflection, personal tags can be added by means of the *Semantic Tagging* service.

This service aims at tagging retrieved resources in order to allow for further retrieval. The learner can therefore tag a resource with a set of assertions representing relevant concepts and attributes. Resources coming from *PKS Repository* have already been tagged by other users, but the learner can decide to add some more tags for her/his private use or for sharing with other learners. So the task becomes a sort of collaborative tagging (Marchetti & Tesconi, 2007). Tagging a resource is made through a proper interface (Figure 6) and consists in selecting concepts and attributes from the ontology. Furthermore, the PKS suggests the most popular tags. Other suggested tags correspond to the elements “subject” and “description” of the DCMI. Therefore the *PKS Repository* is a semantic knowledge base. From a technical point of view, the set of tagged resources is the *assertional box* of the knowledge base whereas the ontology is its *terminological box* (Baader et al., 2003).

The *Document Access* service allows the learner to access a selected resource. This service is interfaced with the most popular resource readers/players such as PDF, DOC readers, and so on. Some resources may be accessible only to authorized users. For example, resources delivered by a publisher or by an institution. Therefore, this service must be able to deal with several learner’s accounts. For the experiment presented in this work, we used Google and Google Scholar where account is not needed.
Use case: “Human Resources” and use case: “My Docs”

These use cases are implemented respectively by the Human Resource Management and by the My Docs modules. The first one provides: Semantic Search, Semantic Tagging, (both similar to the corresponding services of Documental resource management module) and Contact services. These services allows the learner to communicate with people selected as experts thanks to Semantic Search. This service must be interfaced with some popular social networks. Therefore it has to deal with several learner’s accounts. For the experiment presented in this work, we used LinkedIn. If the user has already an account on the selected social network, the PKS will use the information provided in the profile to automatically authenticate the learner; otherwise, learners will need to create the proper account and then update their profile.
The second module provides *Insert Document*, and *Semantic Tagging* services. The *Insert Document* service aims at inserting in the PKS Repository a document or a resource directly produced by the learner. This service is able to work with different file formats.

The *Semantic Tagging* service allows the learner to tag the resource with a set of assertions in a collaborative fashion, as in *Documental Resource Management* modules.

**Scenario of use**

A given LLL begins to use the PKS and needs resources in a given domain, for instance in the case of professional development of Complex System Professionals (Leo et al., 2009). Here we consider an Italian junior systems engineer that has to start working in the field of renewable energies and domotics, not previously studied.

The activities of such engineer through and within the PKS are as follows:

**My Profile**

*Insert Profile*. The learner is guided step-by-step by the PKS in filling up her profile according to the Europass CV model (see use case “My Profile”). She defines: energy resources, domotic, domotics as field of interest; control system design as work experiences; engineering degree as education and training; Italian and English as languages; medium ICT uptake and some social network (LinkedIn) as personal skills and abilities.

*Import ontology*. In our case the PKS does not have related ontologies in the Repository and starts searching among Google.owl ontologies using the keyword “filetype:owl energy resources, domotic, domotics.” The result shows (at November 2011):

a)  https://www.auto.tuwien.ac.at/downloads/ThinkHome/ontology/0_87/EnergyResourceOntology.owl;
b)  http://amigo.gforge.inria.fr/owl/Domotics.owl;
c)  http://elite.polito.it/files/releases/dog/dogont/DogOnt-1.0.5-MaisonEquipee/DOGOnt.owl.

The PKS shows the contents and structure of the ontologies using the interface depicted in Figure 4. The LLL decides to adopt the first ontology in the list because it covers both non formal categories (renewable energy) and disciplinary domain (domotics).

At this point, the learner can search for documental resources and/or human resources.

**Documental Resources**

*Semantic search*. The learner navigates the ontology and selects concepts and attributes. In this case, she selects the concepts “Energy Provider” and “BTicino Component” (which has “Domotic Network Component” as superconcept); they are used to search for documental resources both inside and outside the PKS. In the present case, no documents are available in the PKS repository, so she starts searching Google by keywords. One of the search key selected is “Energy provider,” refined by the learner into “Energy provider Marche region Italy”; among the results, one document of interest is a Wikipedia page about Hera, a company operating in the energy market. Another search key is “Domotic Network Component BTicino Component”. With this second key, several results are listed. Among those, our LLL is interested in the “Social network optimization: the case of BTicino” document.

*Document access*. Firstly, our LLL explores Wikipedia page relative to Hera and consult the page, containing number of interesting links. She decides to save the page. Secondly, she explores and downloads the “Social network optimization: the case of BTicino” document authored by persons apparently authoritative or already known to her; so these are contacts that she will refer to using the Human Resource Module.

*Semantic tagging*. All the downloaded documents are semantically annotated, put in the PKS client and then synchronized with the PKS server. Semantic annotation is guided by the procedure described under *Semantic*
tagging. In our case the Hera company web site is tagged with “Energy Provider Marche region Italy”; the “Social network optimization: The case of BTicino” document is tagged with “Social Network” and “BTicino.”

*Human resources.* Starting from the authors of the “Social network optimization: the case of BTicino” document, our LLL uses her PKS client to handle the authentication for accessing social networks and using their searching services. In the prototype implemented for this work, LinkedIn has been used. The profile of the expert in “project management” is retrieved from LinkedIn and then the LLL has the opportunity to use the social network to contact him.

Our LLL is also interested in searching designers working in the domain. In the Advanced search module of LinkedIn, the PKS automatically proposes the field Keywords (desired employment, as described in the profile), Title (the highest degree of Education and Training) and Industry (non formal category in the interests Renewable energy).

In this last kind of research, the search driven by PKS has to be refined in various ways by the LLL, particularly if the search is not limited to her own country. The translation in different languages of the main search key can produce improper results, due to the different cultures of different countries; there is a problem of semantic inconsistency of the syntax of the research key.

*Semantic tagging.* The profile of the retrieved human resource has to be semantically annotated. The default tags are those published, on LinkedIn profile, and the relative rating, if available. In our case, tags and ratings are “Skills” and “Recommendations” from LinkedIn.

**Discussion and conclusions**

A SOA has been proposed to support knowledge building and sharing for the professional advancement of adult LLLs, not able to attend institutional courses for their learning goals. The distinctive characters of such learners are motivation, capability of self directed learning, and limited technology uptake. Such population represents a large set of professionals, having a traditional educational background and compelled to face new professional challenges in domains they are partially or totally unaware of. They frequently need to discover and acquire tacit knowledge relevant to their professional needs and make it explicit.

The PKS architecture has a number of similarities and some fundamental differences with the PLE construct. One evident difference is that there are neither teachers available nor institutional tutoring/mentoring to plan the learning process and suggest experts. Therefore we suggest a proactive architecture, using semantics, within a collaborative environment. From the functional point of view, the key element is the construction of the user profile based on a specific ontology and the search of ontologies relative to the LLL domain of interest. The LLL has to choose among the ontologies proposed by the PKS.

This is a key point: Indeed the LLL is initially a novice in the domain classified by the ontology. The chosen ontology defines the semantic space for searching documents and people, and organizing the results. It is not rare the case of multiple ontologies relative to the same domain. Moreover the professional problem addressed by the LLL can be multi-domain. This choice has to be made very carefully and has to be open to modifications with the evolution of the LLL competences.

The PKS provides the LLL with tools for adaptivity in respect to the personal profile and for personalization. This fundamental difference with PLE asks for relying again on semantics to assist the learner in the knowledge resources retrieval and organization and in the definition of their personal identity. This is a crucial point for the LLL to be recognizable in the social space; in this way peers and experts, with which to establish a community of knowledge prosumers in relation to the present object of interest, can be found.

On the technological side, the PKS is part of the SaaS delivery model, in a web 2.0 environment. The choice of a SOA seems apt, in principle, to guarantee system flexibility and adaptivity. The choice of relying onto available ontologies seems, in principle, apt to allow ease of use, reducing the risk of ambiguity and inconsistency both in the search of results and in the definition of personal identity. Actually the present diffusion of ontologies would not be
enough for a wide use of such an architecture, but the widespread interest in these topics will hopefully let their number increase rapidly.

The presentation of the PKS architecture is a first step. Future work, in our view, will focus on dynamically updating the profile of the LLL according to the progression of Knowledge construction and collaboration activities.

Notice that the relevance of the problem of an effective exploitation of web 2.0 tools for learning and knowledge management purposes appears to be widely recognized (Seuss, 2011). A number of tools is currently available, mainly for the academic community, allowing users to search for and organize both human resources and documental resources. Mendeley (http://www.mendeley.com) is one such instance. Their present limit is that they are not semantic tools; so their search power is limited to formal documental resources and to self-defined user profiles, which could give rise to ambiguities and inconsistencies.

As it appears in our test case, problems of semantic inconsistency of the research key syntax in different languages have been recognised in LinkedIn and similar problems might be present in other social networks.

References


