Social Semantic Web technologies and tools and their educational applications

Learning technologies have already started to make use of both Social Web (or Web 2.0) and Semantic Web principles, techniques, approaches and tools. Recently, researchers and developers have started to combine these two worlds, thus giving rise to the Social Semantic Web. Consequently, the world of learning technologies turns itself more and more to the Social Semantic Web. Consequently, the world of learning technologies turns itself more and more to the Social Semantic Web as one of its key supporting pillars.

Introduction

The Social Semantic Web (SSW) stands for a new paradigm for creating, managing and sharing information through combining the technologies and approaches from the Semantic Web and the Social Web (Web 2.0). The former aims at giving information a “well-defined meaning, better enabling computers and people to work in cooperation” [Berners-Lee et al, 2001] through the definition of ontologies [Allemang & Hendler, 2008]. The latter is a platform for social and collaborative exchange [O'Reilly, 2005] where users meet, collaborate, interact and most importantly create content and share knowledge through, e.g., wikis, blogs, photo- and video sharing services. SSW has emerged by merging the best of these two worlds, through combining the common formats for defining and structuring information with the social mechanisms for creating and sharing knowledge [Mikroyannidis, 2007]. On SSW, socially created and shared knowledge leads to the creation of explicit and semantically-rich knowledge representations [Gruber, 2008].

This novel paradigm has already started making its way into e-learning and education, as shown, e.g., in [Jovanovic et al, 2009a] and [Tiropantis et al, 2009]. Specifically, SSW has already shown as beneficial for: i) on-demand assembly of course content from existing learning objects [Westerski et al, 2006]; ii) learning and knowledge sharing in collaborative e-learning environments [Auer et al, 2006], [Zacharias et al, 2009], [Schaffert et al, 2006], [Bajanki et al, 2009]; and iii) provision of highly informative feedback for educators [Jovanovic et al, 2007a]. In addition, in her seminal work on the topic, J. Vassileva has covered many other issues with a focus of supporting social learning in context [Vassileva, 2008]. She has analyzed the available technologies, as well as the backgrounds and mindsets of nowadays learners, and discussed their implications for learning process (such as support for finding the right stuff (learning material), support for finding the right people (peers, experts, and the like), and motivating participation). She has also indicated several under-explored areas where a lot of work is needed, such as finding collaborators, learning content sequencing, and design of incentive mechanisms to encourage learning, exploration, participation, and contributions in social learning environments. The issues tackled in OP4L fall predominantly into the area of finding collaborators, but also overlaps in the other areas mentioned.
In this report, we introduce the Social Semantic Web paradigm and present how it can be applied in e-learning for improving current e-learning practices and introducing new ones, especially those related to Personal Learning Environments (PLEs) [Attwell, 2007]. We also show how it helps addressing some of the open research challenges in Technology Enhanced Learning (TEL), including (but not restricted to):

- Enabling effective and reliable mechanisms for managing (i.e., capturing, representing, and evolving) various types of knowledge (e.g., domain, user, and pedagogical) relevant for providing personalized learning experiences in online learning environments. Equally important is the ability to preserve the semantics of this knowledge while sharing it among various learning systems and tools that students interact with during the learning process.
- Providing support for interactivity across diverse learning systems and tools that students turn to during the learning process. Interactivity in the context of learning is largely equivalent to the students' social and creative engagement, that is, communication, collaboration, and authoring [O'Connell, 2007].
- Integrating, sharing and using of interaction data to allow for advanced forms of adaptive and personalized learning.
- Enabling ubiquitous access to learning resources, that is, allowing for access to relevant resources (both human and digital) regardless of the system/tool/service the user is currently interacting with.

**SSW Technologies in Education: the State of the Art**

In this section we first introduce the Social Semantic Web (SSW) paradigm and then proceed to discuss the benefits that it offers for online learning environments in general and Personal Learning Environments (PLEs) in particular.

**The Social Semantic Web**

The Semantic Web has been introduced as the evolution of the current Web in which the Web content is enriched with explicit definition of its semantics thus enabling computers to make better use of that content to facilitate and improve our everyday practices. The key building blocks of the Semantic Web are ontologies. Ontologies are formally defined, shared conceptualizations of a specific knowledge domain. They are expressed through standard languages (such as RDF and OWL), which allow them to be combined, shared, easily extended and used to semantically annotate different kinds of resources, such as Web pages, documents, and multimedia content. By leveraging such ontological infrastructure, various different intelligent services can be built, such as semantic search engines that provide more relevant and fine grained results than traditional search engines through i) the inference of new knowledge based on the knowledge expressed in ontologies and ii) correlating Web content according to the available semantic annotations, and thus interpreting its meaning with respect to the underlying ontologies.

Despite the many promising aspects that we have described, the Semantic Web is still not widely adopted. This is mainly due to the difficulties in ontology creation and maintenance, and
the process of semantic annotation. The development of ontologies is difficult and strenuous for domain experts who typically lack the required knowledge engineering expertise [Hatala et al, 2009]. Despite current efforts to increase the availability and reusability of ontologies, through the development of online ontology libraries (e.g., Swoogle[1] or Schemapedia[2]) or (semi-)automatic ontology development tools, the usage of these libraries and tools still requires a high level of technical knowledge [Gašević et al, 2007].

A new wave of so-called social applications has emerged as a culmination of technology and interaction techniques, and has been labeled the Social Web or Web 2.0 [O’Reilly, 2005]. While much hype has surrounded these recent innovations, the uptake and trends of the software has been significant. The Social Web transforms the “old” model of the Web – a container of information accessed passively by users - into a platform for social and collaborative exchange; in which users meet, collaborate, interact and most importantly create content and share knowledge. Popular social websites, such as Facebook, Flickr and YouTube, enable people to keep in touch with friends and share content. Other services such as blogs, wikis, video and photo sharing that together enable what recently has been defined as “lifestreaming” allow novice users to easily create, publish and share their own content. Further, users are able to easily annotate and share Web resources using social bookmarking and tagging, thus creating metadata for Web content commonly referred to as “folksonomies”. However, Social Web technologies in general, and collaborative tagging in particular, suffer from the problems of ambiguity of meanings. For instance collaborative tags are often ambiguous due to their lack of semantics (e.g., synonymous meanings for a tag). Moreover, they lack a coherent categorization scheme, and require significant time and a sizeable community to be used effectively [Stankovic & Jovanovic, 2009].

Despite the initial perception that the Social Web and the Semantic Web oppose each other, the two efforts are jointly being used to create a common space of semantic technologies. In fact, the Semantic Web cannot work alone. It requires society-scale applications (e.g., advanced collaborative applications that make use of shared data and annotations) [Breslin & Decker, 2006]. Moreover, the paradigm of knowledge creation derived from the Social Web can be effectively used to refine/update ontologies generated according to Semantic Web standards and best-practices. At the same time the Social Web can benefit from the paradigm of structured knowledge, represented with standard languages adopted in the Semantic Web vision. Such standards will make it easier for collective knowledge to be shared and to interoperate with any sort of application.

The idea of merging the best of both worlds has converged in the concept of the Social Semantic Web, in which socially created and shared knowledge on the Web leads to the creation of explicit and semantically-rich knowledge representations. The Social Semantic Web can be seen as a Web of collective knowledge systems, which are able to provide useful information that is based on human contributions, and which improves as more people participate [Gruber, 2008].

Specific examples of the Social Semantic Web are being undertaken in a wide number of projects. For instance, DBpedia[3] is a large-scale semantic knowledge base, which structures socially created knowledge on the Wikipedia, a wiki-based encyclopedia. DBpedia takes advantage of the common patterns and templates used by Wikipedia authors to gather
structured information into a knowledge base of socially created structured knowledge. The result is a huge database of shared knowledge which allows “intelligent” queries such as: “List the 19th century poets from England” [Auer et. al., 2007]. With its capability of answering very specific queries, DBpedia can serve as a very handy learning tool and is an excellent example of the advantages that Social Semantic Web paradigm brings to the educational domain. Throughout the following sections we provide a lot of additional examples of the benefits that the Social Semantic Web brings to education.

The implications of such technologies are significant for the educational domain, where students can find immediate answers to their detailed questions. Moreover, one can envision the “Educational Social Semantic Web”, where learning materials and activities are structured according to sound pedagogical principles, and where activities are easily created, shared, and used by students and teachers; without the need for detailed knowledge engineering skills or know-how of advanced technologies. Specifically, for the field of online learning environments, and PLEs in particular, we see several immediate benefits of incorporating the current capabilities of the Social Semantic Web. We illustrate these benefits in the following sections.

**SSW for Improved Interactivity of Online Learning Environments**

Besides being members of general social networks and social media sites, like Facebook, Twitter and YouTube, many students are also participants to online social networks specifically focused on their studies, like Elgg[4], NoteMesh[5] and CollegeRuled[6]. These networks typically allow students of the same class to share notes with each other, offer a message board and/or a discussion area where students discuss assignments with classmates, ask questions, work in groups, and the like. There are also online social networks aimed primarily at teachers and instructors, for their professional development, as well as collaborative creation and exchange of learning content and instructional practices; examples include Curriki[7], EdTechTalk[8] and EduBlogs[9]. Some online social networks are aimed at connecting students and teachers, like Schoopy[10] and BuddySchool[11]. Finally, there are social networking systems that support continuous development of portfolios. Through interactions within the social network, one’s portfolios can constantly be developed and improved, while the social network can offer different feedback, commenting and rating instruments to constantly provide the evaluation of the produced content published through portfolios. The use of these and similar tools and services can significantly facilitate interaction among the members of an online learning community.

Having recognized the importance of online social networking for education, traditional e-learning environments like Learning Management Systems have started to incorporate well known social networking tools. Currently, the best example of this practice is Haiku[12] Learning Management System that already has over 80 social networking tools ready to embed with just a simple drag-and-drop. Since both students and teachers are used to interacting via those tools and services in their daily practices, there are no barriers for adoption. In addition, the interaction data could be captured internally (i.e., by the system itself), and subsequently used for adaptation and personalization purposes (cf. Section SSW for Improved Adaptation and Personalization in Online Learning).
By leveraging the integration of Social Web and semantic technologies, new, advanced forms of social networking platforms have started to emerge. They allow for advanced forms of social interactions, as well as knowledge creation and exchange. An interesting approach towards enabling advanced forms of social networking by utilizing semantic technologies is provided by Innoraise[13] – a social semantic network enabling one to easily find people knowledgeable in a certain domain and/or about a certain topic. It allows users to find out who knows about their topic of interest, and start to interact, collaborate, and follow the activities of their contacts. In order to enable this, the system aggregates content produced and consumed by users and by employing semantic analysis, information retrieval and data mining technologies, assesses the knowledge of a person. The first social network powered by this solution is STI community[14], an international network of experts in Semantic technologies. Innoraise and similar systems can be used for increasing the interactivity of online learning environments and facilitating collaborative learning approaches – students and teachers can create communities around course topics; develop and exchange knowledge within and across these communities; meet peers studying/teaching the same or similar subjects; more easily search for relevant content by leveraging semantic tags; and get recommendations about relevant resources (both human and digital).

Some emerging software solutions that rely upon the SSW paradigm promise to significantly improve end-users interaction with the content. For example, Parallax[15] offers a new way of browsing and exploring data stored in Freebase[16] – an open, semantically structured database of information of general interest. The tool applies the faceted browsing paradigm to allow for seamless exploration of data. It also enables one to browse from one set of things to another related set of things (e.g., find the architects of skyscrapers in New York and all the structures that they have designed) – a novel and powerful mechanism for exploring the data, much more efficient than the ability to browse from one single thing to another single thing.

Among the key representatives of the Social Web are mash-ups – Web applications allowing users to combine and integrate different types of data, often originating from different sources. Mapping mash-ups, in which maps are overlaid with information, may be the best known example of this rapidly growing genre. Tools, such as Google Refine[17], or Yahoo Pipes[18] allow individuals to mix up data, find new meaning, and present it in interesting ways. The suite of tools developed in the scope of MIT’s SIMILE[19] project (such as Exhibit [Huynh et al, 2007a] and Potluck [Huynh et al, 2007b]) facilitates the creation of Semantic Web mash-ups – by leveraging Semantic Web technologies (primarily RDF and SPARQL), these mash-ups are more dynamic and flexible than those offered by Web 2.0 tools and services. Maybe the most distinctive among those tools is Potluck, a tool that lets casual end-users (i.e. non-programmers) easily make mash-ups of structured, semantically rich data, often expressed in RDF or JSON[20] format. Potluck acknowledges the fact that the real-world RDF is messy, “broken perhaps not just in syntax but also in semantics” [Huynh et al, 2007b], and empowers users to deal with this problem by providing them with visual editing facilities. In particular, the tool assumes an iterative process of data integration in which the user can take advantage of the tool’s rich visualization capabilities to explore the data, identify data of interest as well as merge, align and/or clean up the data – all that in an easy and intuitive manner.
In education, tools like Potluck can be extremely valuable by helping students integrate previously disparate types of information and explore them from different perspectives and more deeply. Not only do mash-ups improve the interactivity along student-content and teacher-content dimensions, but they also introduce a novel form of content-content interaction. In particular, the mash-up resulting from the integration of disparate sources of data brings in a new quality (e.g., a new point of view, or a better understanding of some phenomenon) that is often more valuable than the pure sum of the integrated parts. In addition, mash-ups can be semantically annotated with the data about the context of their creation (who created them, what data sources they used, for what purpose) and used as valuable learning content.

**Supporting Interaction across Educational Applications through SSW Technologies**

Currently, one of the major obstacles to collaborative creation and sharing of knowledge on the Social Web is the fact that online social networks are like isolated islands – knowledge can be exchanged within the island (i.e. network) but not across them, at least not without a lot of effort (i.e. manual copy-and-paste activities). For example, let us consider a student who is studying a certain domain topic and wants to acquire the knowledge on that topic by leveraging the resources gathered by an expert or his/her peers. Unfortunately, resources maintained by those people can be located on many different social networks and social media sites. The student would spend a lot of time manually importing these resources, or may even abandon the operation in favor of using other, potentially less relevant or less trustworthy sources of knowledge.

The integration of the Semantic Web technologies into the Social Web paradigm promises to solve this problem. For example, Social Semantic Collaborative Filtering (SSCF) [Kruk et al, 2006] allows users to easily share their knowledge with others within and across online social networks. For example, one could easily import friends’ bookmarks and utilise their expertise and experience in specific domains of knowledge. In addition, SSCF allows users to set fine grained access rights for their resources. Access control is based on the distance and the friendship level between users which is expressed using FOAFRealm [Kruk, 2004].

Semantic Web technologies are an important part of emerging efforts aimed at decentralization of social networks. The common objective of projects like NoseRub[21] and DiSo[22] is to enable users to own and control their online profiles, including their contact lists and the streams of their online activities. A related project called Knowee[23], initiated by the Semantic Web Education and Outreach[24] group, is aimed at developing a Semantic Social Web address book – a distributed address book releasing users from the mundane task of maintaining their contact data. Instead, Knowee lets users subscribe to diverse Social Web applications and services and the address book updates itself automatically; it also provides the user with his/her integrated social graph.

All the above mentioned efforts are important for e-learning, as they (seam to) offer a solution to the long-standing problem of integrating learner profiles from different systems and tools that learners turn to during the learning process. They can also help to build comprehensive learner models and share them among these systems and tools. This can further contribute to surpassing the paradigm of “walled garden” learning environments (typical for traditional e-
learning systems, like Learning Management Systems) and replacing it with the novel paradigm of PLEs. A PLE allows a learner to interact with diverse systems, tools and services to access content, assess his/her knowledge, collaborate with peers and the like [Attwell, 2007].

Another important project that utilizes the SSW paradigm in order to provide support for interactivity at the Web scale is Semantically-Interlinked Online Communities (SIOC)[25]. SIOC is an initiative aimed at enabling the integration of user-generated content and information contained both explicitly and implicitly in Web discussion methods such as blogs, forums and mailing lists. The cornerstone of this initiative is the SIOC ontology[26] that allows for machine readable and formal representation of all data relevant for keeping track of various kinds of Web discussions. Applied in educational settings, the SIOC ontology enables gathering of data about all kinds of interactions that a student has had on the Web, and allows for the inference of additional knowledge about the student that can be beneficial for improving his/her student model. For example, an ILE could analyze online discussions in which the student participated, and relate messages that the student exchanged with his/her peers to the topics of domain ontologies in order to infer the student’s level of mastery of some of the domain topics. In addition, this offers an additional knowledge base of unofficial content that can be recommended to students while studying related concepts, or to educators for inclusion in the ‘official’ course content. However, in order to fully exploit the potentials offered by the SIOC, we need rules and heuristics that would allow for the interpretation of the interaction data, and inference of relevant knowledge about students.

SSW for Improved Adaptation and Personalization of Online Learning

Current learning practices are often based on individual use of diverse learning systems, tools and services. One of the major problems with this ‘fragmented’ approach is in its lack of means for enabling exchange of data about the activities that students performed within individual learning systems/tools and learning artifacts they have produced during these activities. Besides, with such an approach it is very hard to provide support for context-aware learning services and offer personalized learning experience to students.

In order to address this issue, Z. Jeremic and his collaborators have developed a collaborative learning environment for learning about software design patterns [Gamma et al,1995], named DEPTHS (DEsign Patterns Teaching Help System) [Jeremic et al, 2009]. It relies on the Social Semantic Web paradigm to integrate several existing, proven learning systems and tools and provide students with context-aware learning services. In particular, DEPTHS integrates:

- an existing Learning Management System, which enables students to learn at the pace and in a place that best suit them, providing them at the same time with a variety of learning activities and resources;
- a software modeling tool that enables students to experience patterns-based software development in the context of real-world problems;
- diverse collaboration tools supporting different kinds of collaborative activities, such as discussions, collaborative tagging, and commenting; and
- relevant online repositories of software design patterns that provide students with plenty of important resources on design patterns containing both valuable examples of design patterns in use and instructions how they should be used.
The integration of all these components is achieved by leveraging the LOCO (Learning Object Context Ontologies) framework [Jovanovic et al., 2007b]. LOCO is a comprehensive ontological framework aimed at formally representing diverse kinds of learning situations (i.e., learning contexts), as well as diverse kinds of interactions that occur during a learning process (e.g., students' mutual interactions and their interactions with the learning content). It allows one to formally represent all particularities of the given learning context: the learning activity, the learning content that was used or produced, and the student(s) involved. Accordingly, the framework integrates a number of learning-related ontologies, such as learning context ontology, a user model ontology, and domain ontologies. These ontologies allow one to formally represent all the details of any given learning context, thus preserving its semantics in a machine interpretable format and allowing for development of context-aware learning services. DEPTHS currently makes use of two ontologies of the LOCO framework: a domain ontology is used for representing the domain of software patterns, whereas the learning context ontology was extended to allow for capturing and unambiguous representation of learning contexts specific to the systems and tools that DEPTHS integrates.

Context-aware learning services offered by DEPTHS are accessible to all systems and tools integrated in the DEPTHS framework and are exposed to end users (students) as context-aware learning features. Based on the student’s current learning context, these services provide students with recommendations regarding: 1) relevant Web resources, 2) relevant internally produced resources (e.g., discussion threads, brainstorming notes, and project description) and 3) peers, teachers, or experts as possible collaborators. These recommendations are based on the formally represented semantics of the student's learning context and learning resources (both online resources and those internally produced).

Even though DEPTHS is developed for the domain of software design patterns, with a very slight modification, it can be equally well applied for any other learning domain. DEPTHS is yet another example of how the SSW paradigm can be the key enabler in surpassing the paradigm of “walled garden” learning environments and replacing it with the novel paradigm of Personal Learning Environments. As shown above, the systems and tools that the student interacts within DEPTHS also communicate with each other to exchange the data about students’ interactions and use that data for adaptation purposes, recommendation of content and peers and generation of feedback for teachers (as suggested in [Jovanovic et al., 2007a]).

The integrated interactions data can also be used for enhancing user models (not just student models, but also teacher models) with knowledge about their social relations. These can be expressed by using, for example, the FOAF (Friend-Of-A-Friend) ontology[27]. Due to its popularity and wide acceptance among Web users and communities (the number of FOAF profiles on the Web already counts in tens of millions), this ontology has become the basis for building domain/application specific ontologies for user and group modeling. Moreover, in the context of PLEs, it offers potentials to allow for seeking peer support while studying certain topics, as well as for indicating and/or creating successful learning paths of the fellow students.

Similarly, the interaction data can be used for inferring a user’s reputation, that is, how he/she is perceived by the other members of the community (e.g., how competent a particular student is in a particular subject area according to his/her peers). This knowledge can be represented using the FOAFRealm ontology [Kruk, 2004] – an extension to the FOAF ontology which allows
users to express how well one person knows, or trusts, another – and used by a PLE for providing recommendations.

**SSW for Ubiquitous Access to Learning Resources**

The notion of context as an aggregate of spatial and temporal aspects of a user’s situation is becoming increasingly important with the constantly growing usage of smart phones and emergence of mobile social applications. This nascent but constantly growing trend of location-based social networking and gaming is empowered by GPS technology and platforms like Foursquare[28], Brightkite[29] and Google Latitude[30] that enable one to share his/her location online. There are already a number of services that make use of this public location-data to allow users find their friends located nearby, to discover and share what is happening in the vicinity, or to get contextualized search results. These kinds of services can also be highly beneficial for educational purposes as suggested in [Siadaty et al, 2008]. In particular, the location data can be used for ad-hoc detection of fellow students that are nearby and organization of F2F meetings and assignment-based study groups. This possibility can be especially relevant for blended learning. For example, in the context of DEPTHS (see the previous section), its semantically-enabled peer discovery service might identify student A as the most relevant person for the current problem that student B is trying to solve. Accessing the student A’s online presence data [Stankovic, 2008], the system learns that she is ‘away’ (from her online status), but also that she is in the same building as the student B (from her current location data). Therefore, the system can offer to student B an option to contact student A via SMS for an ad-hoc F2F meeting.

Of course, online sharing of one’s location and other context data has important privacy implications. To deal with them, for example, almost all location-aware service allow their users to turn location sharing off when they want to keep their location private. However, this could be considered just as an initial solution, since more fine grained management of private data should be enabled. New services, such as Geoloqi[31], try to address the privacy issues by enabling their users to define with whom they are willing to share their location data.

The above issues are calling for the use of various ways for regulating access to private data. To date, the most relevant solutions are based on the use of policy languages such as Ponder, KaoS, Rei, PeerTrust, and XACML [Bonatti et al, 2006]. Typically defined over ontologies, policy languages provide a reliable mechanism for (rule-based) reasoning in open environments, where the use of roles and institutions the users may belong to is not possible [De Coi et al, 2008]. Current policy languages rather allow for context-based reasoning where one can only make use of the knowledge coming from the shared vocabularies (i.e., ontologies) and used by different communities and reputation of individuals gained in different communities. However, management of policies today requires a lot of technical knowledge, which in general disables wide adoption of policy-based approaches for privacy protection. Accordingly, there is a need for the development of user-friendly interfaces for policy management. Moreover, we cannot expect that end-users will define a policy for each possible threat that may arise, but we need to develop mechanism for automatic context-aware detection of privacy threats by leveraging the ontology-based definitions of contexts. Similarly to the relations between
ontologies and folksonomies, there is a need to investigate policy languages that allow for reasoning over socially constructed knowledge, in addition to the formally defined ontologies.

**SSW Tools in Education: The State of Practice**

In a recent small-scale study [Jeremic et al, 2011] we have investigated the tools and services that use the Social Web and/or SSW paradigm for educational purposes to get a better understanding of the kinds of tools/services that have actually been used in educational practice and the extent of their use. The ultimate aim of the study was to find out whether and to what extent the tools that are currently in use could actually be employed for increasing the interactivity and collaboration aspects of online learning environments and enable the transition of educational practices towards the PLE paradigm.

The applied methodology included three primary steps: 1) identification of potentially relevant tools[32], 2) analysis of candidate tools with respect to a predefined set of criteria, and 3) selection of representative tools. Since social software tools and their semantically enhanced counterparts differ with respect to the underlying technology and the general level of maturity, we had to apply somewhat different approaches when reviewing and analyzing the tools from these two categories. To keep the narration clear and avoid any potential ambiguity, in the rest of the document we refer to the former category of tools as social software tools and the later as SSW tools.

To select potentially relevant tools, we made use of both scholarly publications (i.e., journal, conference, and workshop papers), and Web content (content of, e.g., blogs, wikis, and discussion forums) generated by learning professionals worldwide. The latter source, even though less formal, is continually growing in both quantity and relevance and offered us with great insights into educators real-world experiences with diverse Web-based tools. We also explored published surveys (e.g. SemTech Survey[33] and [Tiropanis et al, 2009]), tools listings (e.g., Sweet Tools[34]) and ratings (e.g., The 100 Tools for Learning[35]) of Web-based tools used for learning purposes.

The common criteria we used for the analysis of both kinds of tools are: 1) the ability to support, or even foster, interaction and collaboration within an online community; and 2) the tool’s applicability for educational purposes. Our choice to focus on interactivity of the considered tools was motivated by the fact that interaction is one of the key characteristics of the PLE paradigm [Attwell, 2007]; additionally, its pedagogical value is stressed by the major modern learning theories [Jovanovic et al, 2009a]. The criterion related to interactivity was further narrowed down to: interactions among members of an online learning community, and interactions with learning content. An additional third criterion, defined only for SSW tools, was the use of Semantic Web technologies for achieving advanced functionalities.

Even though social software tools have not yet become part of educational technology mainstream, they have reached a high level of maturity and have been increasingly adopted in educational practices worldwide. On the other hand, SSW tools are still quite immature and there is a scarce evidence of their application in real-world educational settings. Therefore, we had to use different approaches when eliciting representative tools of these two categories of
tools. The social software tools were chosen based on the documented experience of their usage in learning settings, as well as their ratings in the previous studies. For example, the yearly report on the 100 Tools for Learning produced by Centre for Learning and Performance Technologies[36] provides practitioners' (i.e. teachers') perceptions of and opinions about each tool included in the list. Likewise, interviews and panel discussions with educational professionals and practitioners[37] provide insight into their experience with different social software technologies and tools. For the other category of tools – SSW tools – we present all the tools we identified that ‘passed’ the first (support for interactivity) and the third (advanced functionalities achieved through the use of Semantic Web technologies) criteria of the analysis phase. We did not strictly consider their successful application in educational settings (as the evidence of their usage is generally lacking), but considered their potential for use in education (mainly based on their features).

Our results are summarized in Table 1 in the Appendix, where we present the selected representative sets of both social software tools and SSW tools. Both kinds of tools are grouped into two broad categories based on the kind of interaction they (primarily) support: 1) interaction among members of an online learning community; and 2) interaction with (learning) content. Each of these categories is further narrowed down into subcategories reflecting the primary functionality offered by the tools within that subcategory (e.g., social networking, collaborative authoring, etc). It is important to stress that this is not a strict classification of tools since a significant number of them could be placed into more than one of these subcategories.

References


Appendix

Table 1. An overview of the state-of-the-practice in social software and SSW tools/services, and their contribution to the interactivity and collaboration aspects of online learning environments.

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<th>Interactivity types</th>
<th>Tool types</th>
<th>Social software tools</th>
<th>Social Semantic Web tools</th>
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<tbody>
<tr>
<td>Interaction among members of an online learning community</td>
<td>Social networking tools: (online discussions, content sharing, tagging, commenting, content/peers recommendations)</td>
<td>Special focused learning groups within general online social networks, like Facebook, Plaxo, YouTube</td>
<td>Special focused learning groups within general online social semantic networks, like Twine (<a href="http://www.twine.com/">http://www.twine.com/</a>), Innoraise (<a href="http://innoraise.com/">http://innoraise.com/</a>)</td>
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<tr>
<td>Interaction with learning content</td>
<td>Social bookmarking and annotation tools</td>
<td>Tools for creating mash-ups</td>
<td>Services providing data for mash-ups</td>
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### Tools for manipulating RSS feeds

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<th>Tools</th>
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[2] FOAF export plugin is necessary to provide Semantic Web functionality.

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[1] [http://swoogle.umbc.edu/](http://swoogle.umbc.edu/)
[3] [http://dbpedia.org](http://dbpedia.org)
[4] [http://elgg.org](http://elgg.org)
[12] [http://knowee.net/](http://knowee.net/)
[13] [http://www.w3.org/blog/SWEO/2007/03/06/community_project_support](http://www.w3.org/blog/SWEO/2007/03/06/community_project_support)
[14] [http://sioc-project.org/](http://sioc-project.org/)
[17] [http://foursquare.com/](http://foursquare.com/)
[18] [http://brightkite.com/](http://brightkite.com/)
[21] In order to reduce the clutter and make the text easier to read, we use the term ‘tool’ as generic term when referring to different kinds of tools, systems and services.
[22] [http://semtech-survey.ecs.soton.ac.uk/](http://semtech-survey.ecs.soton.ac.uk/)
[35] http://www.c4lpt.co.uk/recommended/top100.html
[36] http://www.c4lpt.co.uk/
[37] Available as podcasts on, for example, http://www.educause.edu/podcasts, and http://cider.athabascau.ca/CIDERSessions/