The Second International Conference on e-Learning (eLearning-2011), 29-30 September 2011, Belgrade, Serbia

USING ONLINE PRESENCE TO SUPPORT COLLABORATIVE LEARNING IN PERSONAL LEARNING ENVIRONMENTS: THE OP4L APPROACH

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Abstract. *Nowadays, when social software tools and services have become the primary communication media and integral part of the new generation's personal lives, it is more than obvious that it is necessary to make them an integral component of educational context. Social software offers various advantages in educational context: they facilitate collaboration, knowledge sharing, group formation around common interests, active participation and reflective thinking. In addition, they allow for establishing and maintaining one's presence in the online world. By being aware of a student's online presence, a learning system is better able to adapt the student's interactions with his/her social environment. In this work we present our current results done in the scope of OP4L project, aiming to facilitate and foster learning by leveraging the synergy of Semantic Web technologies, online presence and socially-oriented learning theories.*

Keywords: *Online Presence, Educational Services, Ontologies*

1. INTRODUCTION

The integration of social software tools into online learning environments was one of the main drivers towards Personal Learning Environments (PLEs) [1]. The notion of PLE assumes personal selection and aggregation of different, often Web-based tools and services into a learning environment fully customized to the needs and preferences of an individual learner. In a PLE, learning activities are not confined within the "walls" of one system/tool, thus enabling learners to make use of a wide diversity of resources (content, tools, and services) available on the Web. Social software tools, as the core elements of a PLE, support community building and networking across course boundaries. Finally, the notion of PLE assumes that a learner is in control of his/her learning process and empowers him/her with the ability to select, use and mashup those resources that are most appropriate for him/her.

An important feature of almost any social software tool is that it supports users in maintaining their online presence. The notion of online presence encompasses a user's overall presence in the online world and is comprised of the posted status messages, availability indicators, geo-location, avatars, etc [2]. By describing the nature of their presence in the online world, users are able to maintain some form of passive interaction with their peers. In a PLE, the notion of global online presence, i.e., student's online presence expressed on different tools integrated into his/her PLE, is especially important. By giving students insights into their classmates' activities, availability for chat, information about work overload, emotional state, likes and dislikes, and all of that regardless of the particular social tool they are using in the given moment, students' global online presence can provide those missing nonverbal cues typical for face-to-face interaction. This further increases students' awareness of each other and positively affects their willingness to collaborate [3]. However, there is still no systematic solution to exchanging and integrating online presence data from different social software tools. This is due to the differences in the online presence data kept by different tools as well as different representations of semantically identical data [4].

One of the key technical challenges for the realization of the PLE concept is exactly the integration of different tools and services a PLE should comprise [5]. A recent trend that promises to offer a solution to this problem relies on the use of Semantic Web technologies. These technologies enable the integration of data and knowledge originating from disparate and often heterogeneous sources (tools/services) and as such could allow for combining and exchanging data among the tools and services integrated in a PLE. In addition, they could be applied for modeling the semantics of one's presence in the online world, with the final aim of enabling interoperability among services that collect and use online presence data.

Accordingly, in the scope of the OP4L (Online Presence for Learning, http://op4l.fon.bg.ac.rs/) project we made use of ontologies to unambiguously represent all relevant data about students online presence, their mutual interactions, as well as their interactions with learning resources. On top of these data, we have developed educational services for recommendation of relevant learning resources (both digital and human). These recommendations are based on the student's overall learning context comprising online presence as one its core determinants. Being aware that it would be naive to expect that the technology itself could bring the desired learning results, we have coupled our technical solution with a proper pedagogical approach based on modern learning theories, namely social constructivism and connectivism.

This paper presents the work we have done thus far, in the scope of OP4L project, aiming to facilitate and foster learning by leveraging the synergy of Semantic Web technologies, online presence and socially-oriented learning theories.

2. BACKGROUND

In recent years we are witnessing a rising interest in and acceptance of Vygotsky's Social Development Theory [6], connectivism [7] and other modern pedagogical theories, which argue for learners' active involvement in the learning process and construction of knowledge through social interactions. Vygotsky's theory is one of the foundations of social constructivism. According to him, social interactions play a fundamental role in the process of cognitive development of a student. Students are constructing new ideas based on their prior knowledge as well as social interactions with other More Knowledgeable Others (MKO). The MKO (teacher, expert, other peer) refers to anyone who has a better understanding or ability level, with respect to a particular task or concept. In his learning theory, called connectivism, Siemens [7] emphasized the effect technology has on learning. According to Siemens, knowledge is gained by connecting with other individuals in a network through the use of appropriate technology.

PLEs incorporate the strengths of constructivism and connectivism learning theories as well as Self-Regulated Learning [8]. Among other things, applying these approaches in the context of a PLE requires information about students' presence in the online world: who is currently present in the learning environment, who is available for communication, who is occupied and unavailable for other activities, etc. By providing additional data about learners present state, online presence allows for more subtle personalization and higher-quality recommendation (e.g., not recommending collaboration with a peer who is currently busy and does not want to be disturbed). Learners' online presence data might also reveal their current real world location, thus allowing the system to give recommendations regarding peers who are nearby and could be contacted for an ad-hoc F2F meeting.

There are several significant studies which have explored the notion of presence in online education and its implications on the learning process. The studies have shown that social presence is one of the most significant factors in distance education [9] in terms of improving instructional effectiveness, initiating in-depth discussions, promoting collaborative learning, as well as building of a group's *online sixth sense* and thus improving the group's cohesion [3].

Furthermore, researchers have found a relationship between social presence and student satisfaction in learning environments [10,11,12]. Relationship between social presence and student learning has been investigated in several researches. Strong relationship between students' perception of interactions with other students and quality and quantity of learning has been reported by Picciano [13].

In today's online learning environments, students' online presence (on diverse online social software tools) is the primary mean of establishing and sustaining their perception of social presence in online learning environments. To the best of our knowledge, most of the existing research work in this area considered discussion forums and IM tools as the means for establishing social presence in e-learning environments. As social networks are becoming a prevalent way of communication between students today, our research is focused on investigating how students' online presence within online social networks could be leveraged for facilitating and even motivating learning activities.

3. SCENARIO OF USE

In order to illustrate how we tackle the aforementioned challenges, in this section we will go through a scenario involving a student named Tom who is working with his classmates on a software design problem related to the Composite design pattern [14]. The given problem has to be solved in a workshop-like manner by performing several predefined tasks: brainstorming, creating and submitting solutions, evaluating each-others solutions, etc. The idea behind these activities is to foster students' creative thinking and collaborative knowledge building processes.

Tom is supposed to present how he would solve the given problem, as well as comment on and rate ideas given by other students. In order to get the required information for performing this task, he searches online repositories for content on the Composite design pattern. Afterward, Tom is using a UML modeling tool enabling him to draw a solution to the given problem in the form of UML diagrams, and upload it to the Learning Management System (LMS) used for the course. From within the LMS, teachers and other students are able to assess Tom's solution and give him the feedback. Unfortunately, Tom got stuck with his assignment and would like to ask his peers for help, but he is not sure who is the most competent to ask. He would highly appreciate a recommendation regarding whom to contact for assistance.

In the proposed solution, Tom would be recommended to contact Sheila, Alex or Mark, as colleagues who, based on their user profiles have enough knowledge of the Composite design pattern or other similar software design problems and would be able to help. Tom could look up for them on the LMS's online chat tool, but they might not be online there. However, most probably they would be online on their favorite social networks - socializing with their friends on Facebook, following news updates on Twitter, wandering around the town but updating their location via Foursquare, etc. In the proposed solution, Tom's LMS is able to present him with this information. It is able to pull the online presence data of his peers from the popular social networks and display their availability for chat or their recent activity. Based on Mark's 'work overload' custom message, the system is able to detect that he should not be considered for asking for help as he probably wouldn't have time for it. Similarly, Sheila's custom status 'available for friends'

indicates that she is available only for her friends, and Tom is not one of them. Luckily, Alex is currently available on Facebook, so the system recommends Tom to contact Alex by sending him a message to his Facebook message inbox. If the system had not have access to the Tom's peers' online presence data, it would have made incorrect recommendation by suggesting Tom to contact any of the three knowledgeable peers even though they wouldn't be able to help him.

4. OP4L SOLUTION

In this section, we present the OP4L solution which is designed to support and promote online presence as a mean for improving the students' collaboration and willingness to share content and knowledge while learning online. In addition, the availability of online presence data allows for making better recommendation of peers to contact for help.

The core of the OP4L environment is DEPTHS (Design Patterns Teaching Help System), a comprehensive learning environment for collaborative project-based learning of software design patterns [15]. By using a common ontological foundation (described in the next section), it integrates several existing educational systems and tools, namely: an LMS, a Domain Modeling tool, Online Repositories of Learning Resources and a Feedback-generation tool. In addition, DEPTHS comprises several context-aware educational services aimed at enriching and fostering learning processes by recommending appropriate learning content (e.g., Web pages, lessons or discussion forum postings), as well as fostering informal learning activities by bringing together students and experts that are dealing with the same software problem or have experience in solving similar problems.

4.1 Ontological Foundation

LOCO [16] is a generic framework for formal representation of the learning context: the learning activity, the learning content that was used or produced, and the participants in the learning process. Accordingly, LOCO is composed of several ontologies[1], such as Learning Context ontology, Domain Model Ontology and User Model Ontology. Following the Linked Data best practices[2], LOCO establishes connections with well-known and widely used ontologies such as the Dublin Core vocabulary, FOAF (Friend-Of-A-Friend,), and SIOC (Semantically Interlinked Online Communities). DEPTHS is relying on the LOCO's Learning Context Ontology for semantic representation of student's overall interaction with the learning content and other participants in learning activities. This data is then used by DEPTHS for performing context-aware retrieval of resources on software design patterns from online repositories and its own repository of software artifacts (which primarily contains artifacts produced by students and shared by the community).

For describing software design patterns and other software engineering related concepts, SKOS (Simple Knowledge Organization Scheme)[3] is chosen as a formal model for describing controlled vocabularies. This allows for easy extending of the domain vocabulary, publishing and linking it with other data on the Web. DEPTHS uses these vocabularies to annotate semantically relevant online resources and extract metadata that is used for finding resources appropriate for a student's current learning context.

The aim of the Online Presence Ontology (OPO)[4] is to formally represent all fragments of a user's Online Presence description dispersed on a wide variety of social software tools and networks and enable integration and exchange of those data [4]. Online Presence can be seen as dynamic part of user profiles in online services, as opposed to static parts, already well supported by the FOAF ontology. OPO has a high goal of enabling interoperability between applications that publish Online Presence data. In OP4L, OPO is used for representing and unifying students' online presence over different tools and services integrated into DEPTHS.

4.2 Online Presence Ontology Server - OPOS

OPOS acts as a hub capable of pulling one's online presence data from various social services (Fig. 1). It stores that data and makes them accessible to the applications the user has selected as trusted ones. In learning settings, OPOS is used for providing the Online Presence data for the potential peer collaborators the system has suggested.

OPOS enables its users to register their accounts on different social tools and services and assign the privileges to access their online presence data from those accounts. Periodically, OPOS pulls the data from the user's accounts and stores them in the local data repository. Since the majority of social tools and services support only certain aspects of one's online presence and that data are presented in different formats, OPOS relies on the OPO ontology to represent and store the online presence data in a common, semantic-rich data representation format. This way, it constructs user's *global online presence*. OPOS is also able to synchronize one's online presence description over user's accounts on different services by updating them with the latest update of the user's online presence.

The architecture of OPOS consists of several parts:

- *Social services*. Online presence data are part of every user profile on any online social network and instant messaging service. Depending on the type of social service, online presence data are pulled from the service using either a plug-in developed for that purpose, or the API provided by the given service.
- *OPOS Core*. The key component of the OPOS is OPOS Core, which is in charge of management of all online

[1] http://jelenajovanovic.net/LOCO-Analyst/loco.html

[2] http://www4.wiwiss.fuberlin.de/bizer/pub/LinkedData-Tutorial/

[3] http://www.w3.org/TR/skos-reference/skos.html

[4] http://online-presence.net/ontology.php

presence data that come to OPOS. It has access to all users' preferences, and stores online presence data upon receiving them.

- *OPOS mediators*. Since every social service is specific in terms of the kind of data it provides and the offered ways for accessing that data, for every social service, a specific mediator serves as a bridge between the OPOS Core component and the service itself. It knows how to handle all data and any requests between OPOS and specific social service.
- *OPOS data repository*. All online presence data are gathered and stored in the data repository in the form of RDF triples. This enables the integration of users' online presence data from various social services across the Web. Furthermore, SPARQL endpoint and RESTful services are provided which give the possibility for querying the data repository.
- *OPOS web application*. Users are able to access OPOS through a web application, which enables them to specify which social services they want to include in OPOS. For every service, it is possible to declare whether a user wants to receive his/her online presence data from and/or send data to that service.

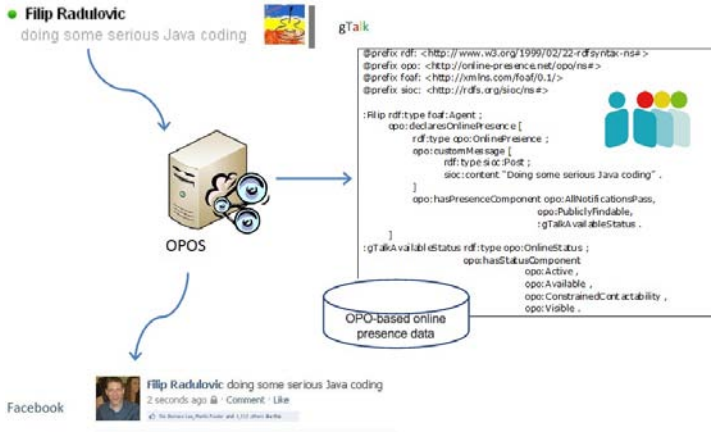

Fig. 1 Online Presence Ontology Server - OPOS

The very fact that OPOS handles one's online presence data – considered by many as sensitive data – raises privacy concerns. This is something OPOS has yet to tackle as its primary focus is to materialize OPO's main idea of aggregating and exchanging online presence data coming from various services. A potential approach we are currently experimenting with is to implement oAuth protocol (http://oauth.net/), a de facto standard authorization method with all popular social applications. This would provide users with the possibility to authorize other applications to access their data stored on the OPO server. The crucial point here will be to endow users with fine grained configuration and full control over which data is being shared.

4.3 Online Presence of Recommended Peers Module

Online Presence of Recommended Peers (Fig. 2) is developed as a module of the LMS integrated into DEPTHS PLE. This module uses Peers Recommendation Service (explained in Sec. 4.4) which is responsible for analyzing student's learning context and the creation of a list of users who are potentially relevant for the considered learning context. For each peer selected as potentially relevant, a query is sent to the OPOS data repository to retrieve his/her latest online presence data. The retrieved data are used to provide visual indication of the peer's presence on different social tools and services integrated in the PLE.

Fig. 2 Online Presence of Recommended Peers Module

When a student is in a need for contacting a colleague, e.g., to ask for help with the current assignment, he/she could take a look at the peers listed in the Online Presence of Recommended Peers Module and choose one of those whose online presence indicator suggests that he/she is free to be contacted. The chosen peer could be contacted directly within the social tool he/she is using in the given moment. After receiving the notification message, the peer is able to respond by giving answers directly from the social tool, i.e., he/she does not need to change the present learning\leisure context.

4.4 Educational Services in OP4L

Context-aware learning has gained an increasing attention in the e-learning research community recently. Despite different interpretations of the term 'context', researchers seems to agree that a learning context is about the environment, people, tools, resources and learning activities [16]. In this research, we slightly extend this notion of learning context to include also the users' online presence data.

In order to provide effective, context-aware learning DEPTHS offers the following educational services: Semantic Annotation and Indexing Service, Resource

Recommendation Service and Peers Recommendation Service.

Semantic Annotation and Indexing Service is used for semantic annotation and indexing of online resources in publicly accessible repositories, as well as internally produced content (created by students). This module analyses text of each document, recognizes specific domain concepts defined in the domain ontology, finds what the document is about and how relevant it is for a specific domain concept. In order to find what the document is about, we used proven statistical measures, namely term frequency-inverse document frequency (TF-IDF) and cosine similarity [17]. TF-IDF is used to evaluate how important a word is to a document in a collection. This way, a collection of relevant documents is created for each domain topics. Afterwards, cosine similarity compares each document with an imaginary document (whose relevance is ideal), and sorts the documents in the collection based on their similarity, i.e. their relevance for a specific topic. Semantic annotation of the internally produced content is performed in a similar way.

Resource Recommendation Service employs student's current learning context, and generates a list of recommended Web resources or internally produced content. To do this, it computes the relevance for each resource for the student's current learning context and selects the most relevant pages or internal content for the student. The computation of relevancy is based on the semantic metadata produced by Semantic Annotation and Indexing Service and formal representation of the student's current learning context represented in accordance with the LOCO's ontologies. The service also makes use of students estimation of the resource's relevance for the current learning context (each time a student visits a suggested resource, he/she is asked to rate its relevance for the given context). Thus, students' ratings affect the resource's overall rating.

Peers Recommendation Service suggests other students, teachers or experts as possible collaborators. Collaborators are selected and sorted using an algorithm which estimates on three different levels their competence to provide help. The highest influence on the estimation of someone's competence to provide help has the estimated knowledge of the same topic, i.e. the ability to resolve the same software design problem the student needs help with. Smaller, but still high influence is given to someone's knowledge of similar or related topics. We believe that somebody is able to assist a student in need of help even if he/she hasn't solved the same problem, but has some experience with similar or related problems. The least influence is given to the knowledge of broader topics, e.g., ability to solve design problems that belong to the same course as the problem the student needs help with. On each of these levels, we are assessing three types of indicators: i) the kind of learning activity one has participated in (e.g. brainstorming, submitting or assessing peers' work); ii) knowledge level as valued by the teacher and peers (including peers' evaluations of the submitted projects and ideas rating); and iii) social connections with the student asking for help – the stronger social connection with a specific person, the higher is the estimation of the peer's competence to help student.

After the assessment of potential peers is performed, a list containing relevant peers sorted by their competences to help student in the current learning context is displayed (in the Online Presence of Recommended Peers module, Fig. 2). However, as these peers are not available all the time, additional check of their current online statuses is performed. OPOS is contacted for the information about their current presence on social networks integrated in the PLE. Additionally, an icon for reaching peer through the social network he has account on is displayed. Thus, if a peer is not available in the LMS at the moment, the student will have indication which social network he/she is available on and will be able to send him/her a message with direct link to the learning context the student needs help with. Having received the notification, the peer can read the message and access the software design problem within the social network to check if he can offer help.

Yet another feature provided for students in the OP4L environment is Social Streaming functionality, giving students a possibility to subscribe to a specific learning context, such as a software design problem, a brainstorming or a discussion thread. If a student decides to subscribe to a specific learning context, he/she will be notified about each social event happened in the selected learning context, e.g., a solution has been submitted for the problem being followed, a new post appeared in the discussion thread or a new idea was presented in the brainstorming thread of student's interest. The notification is in the form of a message sent automatically to the social tool he/she is using at the moment.

5. OP4L IMPLEMENTATION SECTION

In OP4L we used two frameworks developed in our previous research projects, namely DEPTHS [15] and OPOS (http://goodoldai.org/project_opos). Within DEPTHS environment we have integrated the Moodle LMS and ArgoUML software modeling tool. Moreover, we use semantic annotation services of the KIM framework (http://www.ontotext.com/kim) to provide semantic annotation of the online resources and internal content produced within LMS. For the purposes of OP4L project we have extended DEPTHS with Facebook and Twitter integration components. As for OPOS, up to now, it supports the following social services: Facebook, Twitter, Foursqare and instant messaging client Spark. For communicating with these services, it uses their corresponding APIs. Communication between all components within the system is enabled through the use of RESTful services implemented using the Jersey framework. RDF repositories are implemented using Jena SDB which enables scalable storage and query of RDF data using relational databases. As our backend applications are based on the Java technology, we used Jenabean framework for bidirectional mapping between RDF triples and Java OO model.

6. RELATED WORK

Having analyzed literature we found several research efforts related to the work described in this paper.

meNow Schema (http://crschmidt.net/semweb/menow) is a simple formal model allowing people to describe their current online status. However, this schema is relatively poor in capturing the semantics of status messages and states of availability.

In [18] a theoretical model for capturing the semantics of Presence in Social Networks has been suggested. Unlike other models, this model does not represent just the phenomenon of presence, but also emphasizes the presence data publishing and consumption aspects, as well as the purpose of the presence data. However, there is no information about the formal specification of this model.

An e-learning framework proposed in [19] supports recommendation of peers based on a student's context. The student's context is defined as a result of the interaction of three key elements: the knowledge potential, the social proximity and the technical access. Comparing to the OP4L's approach to recommendation of peers, this approach presented is advantageous as it considers technical context that includes factors such as technical media or time proximity. However, that approach does not consider the influence that a student's participation in the learning activities has on his competences to help other students, neither it considers students' online presence.

7. CONCLUSION

In this paper, we have presented how we make use of Semantic Web technologies to integrate and unify students' online presence data. These data are further fed into advanced educational services that leverage students' overall learning context to recommend them relevant learning resources (both digital and human). This work is a part of our broader research efforts, conducted within the scope of the OP4L project, to better support collaborative learning in personal learning environments.

Presently, we are finalizing the testing of the developed software components (see Sec. 4) and designing the evaluation study. The study will be conducted during the winter semester of the 2011/12 academic year in high education institutions of our four project partners. The primary research questions to be investigated in this study are focused on the role of *global online presence* in PLEs, namely, its influence on i) the perceived usefulness and usability of the peer recommendation service, and 2) students' overall learning experience.

Acknowledgments. Research presented in this paper is conducted within the SEE-ERA Net Plus project OP4L, project no. SEEERAPLUS-115.

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