Semantic Recommendations and Adaptations for a collaborative and pervasive IBST scenario

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Abstract: A major challenge for future technology-enhanced learning systems is to combine the benefits of learning management systems, personal learning environments, social media software and pervasive learning environments. Our viewpoint is that future pervasive learning environments will be based on contextual adaptation and recommendations of pedagogical activities and resources based on a semantic web approach to provide on the fly the distributed software environment, composed of appropriate standards tools, to enable the fulfillment of proposed or chosen assessable activities in a social environment. We are more particularly interested in collaborative and pervasive inquiry-based science teaching approaches. Inquiry-Based Science Teaching in the context of History of Science and Technology provides a rich context for pedagogical scenarios. In such a framework, semantic recommendations and adaptations are presented to enhance collaborative learning among students, according to an improved IBST scenario.

I. Introduction

Nowadays, technology-enhanced learning systems can be build on learning management systems (LMS) or personal learning environments (PLE). LMS provide administrative services. The main drawbacks are that those tools are pre defined and the corresponding pedagogical approaches are implicit and frozen. PLE are distributed, personalized and composed of separated tools, social media applications. From an educational perspective, social media applications including blogs, wikis, rich media sharing, etc. fit well with socio-constructivist learning approaches as they provide spaces for collaborative knowledge building and reflective practices. These social media tools are used in informal learning settings commonly found outside formal and institutional learning environments. In PLE, learning objects are distributed on the web in different tools that do not provide interoperability; activities are implicit and difficult to monitor; learners traces are almost impossible to get. Those environments are at present exclusive (Dalsgaard 2006).

Moreover, pervasive learning is recently becoming an important issue in technology-enhanced learning field. Pervasive computing has the ability to increase our capability to physically move computing tools and services with us and to inquire, detect and explore the surrounding environment in order to obtain information and to dynamically build context models that allow supporting different aspects of the learning process (Lyytinen and Yoo 2002). For instance, computers can obtain information about the context of learning from the learning environment where small devices, sensors, pads, badges, learners, teachers or tutors, communities and so on, are embedded and communicate mutually. The physical environment is directly related to learning goals and activities. New situated learning activities may be achieved to enhance the learning process that was difficult to realized before (even impossible before). Context based activities, or pervasive learning, imply the ability to provide the right content, with the right tool within a well-suited activity. Social interaction in such context makes necessary the interoperablity of data across tools. Assessment of activities (either formative or summative) calls for learning trace access. All of this also means that pedagogical activities should be adapted on the fly in an open, distributed environment, requires the definition of models, based on knowledge models and pedagogical theories, used by a distributed adaptation framework.

Our viewpoint is that future pervasive learning environments will be based on contextual adaptation and recommendation at the right moment of pedagogical activities and resources based on a semantic web approach to provide on the fly the distributed software environment, composed of appropriate standards tools, to enable the fulfillment of proposed or chosen assessable activities in a social environment (Gilliot 2009). We are more particularly interested in collaborative and pervasive inquiry-based science teaching approaches.

II. Original IBST Scenario

At the European level, the lack of interest by students in science or in the scientific careers has led to a call for research projects in science education (the FP7 “Science in Society” program) and the publication of the Rocard Report (Rocard 2007) about Science Education where recommendations promoted an evolution of teaching methods toward Inquiry Based Science Teaching (IBST). Inquiry-based science teaching may be defined as follows. It is characterized by activities that pay attention to engaging students in:

1. Authentic and problem-based learning activities which are ill-defined and have several answers
2. A certain amount of experimental procedures, experiments and activities involving practical experience of equipment and including searching for information
3. Self regulated learning sequences where student autonomy is emphasized
4. Discursive argumentation and communication with peers ("talking science")

One of the most cited reference refers to the definition proposed by Linn et al. (2003): « we define inquiry as engaging students in the intentional process of diagnosing problems, critiquing experiments, distinguishing alternatives, planning investigations, revising views, researching conjectures, searching for information, constructing models, debating with peers, communicating for diverse audiences, and forming coherent arguments ».

The objective of the FP7 Project *Mind the Gap* (n° 217 725) was “to stimulate a more engaging and interesting science teaching based on principles of IBST so that more young people in general, and girls in particular, wish to pursue educations and careers in science and technology”. The work package 5[3] was dedicated to the role of ICT in IBST (Gueudet et al 2009, 2010). The research team PaHST (University of Brest) was in charge to study the role of ICT resources in history of science and technology for IBST (Laubé 2009). As results of the research studies, a HST-IBST website was created (see: http://plates-formes.iufm.fr/ressources-ehst/spip.php?rubrique17) (Laubé 2010). The purpose is to provide historical online resources for teacher training. A dual approach is adopted: 1) The resources are derived from research conducted in History of Science and Technology in our lab PaHST (and validated at the university level), 2) IBST is the teaching method to be learned by the students. The website is used in our Institute for Teacher Training in Brest in the framework of the recent master dedicated to education, but also for in-service teachers.

In this paper, we choose an example based on a historical problem of technology - the swinging bridge of Brest over the Penfeld (1861-1944). It is extracted from a scenario dedicated to pre- or in-service teachers at primary school. From that original scenario version, we focus on a collaborative and pervasive scenario enhancing the original one (defined in the workshop paper of J-M Gilliot et al.). The scenario is composed of six steps: problem analysis, activation of prior knowledge, elaboration of a common strategy, exploitation of collected information, collaborative report writing and institutionalization. The scenario is as follows:

1. Problem analysis in small groups. The problem will be based on an open question, such as evolution of industrial landscapes
2. Activation of prior knowledge through small-group discussion. The group has to determine the well-known keywords (as prior knowledge) and the unknown keywords (knowledge to acquire)
3. Elaboration of a common strategy to find needed information: for instance, why a bridge, where and how? The group explores the information space, quickly. It defines the set of activities, which will be achieved in cooperation (activities distribution) or in collaboration (all together). The group is divided into three subgroups to combine site visit and information seeking in navy museum, local public records, and on the web.
4. Exploitation of collected information, based on information seeking (restructuring of knowledge)
5. Collaborative report writing (social knowledge construction)
6. Institutionalization (tutor synthesis)

Cooperative activities: the visits of sites, navy museum and local public records, etc. have to be coordinated. One subgroup visits the historical site to gather geographical information, photos, and to relate historical information with modern site architecture. The other subgroups search for additional information in the navy museum and the local public records (one group each). Sometimes according to information gathered on historical site, or in museum or in public records, co-ordinations and communications must be done to enhance and to "synchronize" information seeking and knowledge discovery with other group members. The group has to share information (images, bookmarks, notes, annotations, texts, video, etc.) according to chosen tools.

Such a scenario combines group activities, information gathering, communication with mobile, mobility and geolocalization, working with maps, simulation, collaborative and cooperative activities, collaborative writing, etc. On the teacher side, other activities have to be considered to complete the information system:

- Group tutoring, which may be analyzed thanks to identification of collaboration, cooperation, hypothesis and tracks explored.
- Individual tutoring, which may be facilitated with work trace analysis, or relevant activity indicators.

To enhance this scenario, we add recommendations as defined in the following paragraph.

III. Pervasive IBST scenario

Pervasive IBST scenario (p-IBST) means that the scenario is able to recommend suitable entities (resources, activities, tools, persons) depending on the current situation without any human interventions (Bouzeghoub et al. 2010 a, 2010b 2009) (Pham Ngyuen et al. 2009 a, 2009 b). A situation is a subset of properties accessible from the context at a given moment (localization, device, current activity, etc.). The system is thus proactive and decides when groups or individuals are notified according to the situation changes. The group/individual can select or not one of the given recommendations. We call this functioning mode system-oriented or push mode because the system controls the recommendation of entities.

We assume that a set of activities are defined and identified. Activities are assigned to individuals, group or subgroup members. Current activities of individuals or subgroups are declared and could be known.

Considering the original IBST scenario (cooperative activities), we propose three push mode examples to illustrate the p-IBST, as follows:

a. Recommend information from Navy museum and local public records retrieved by other group members or subgroup according to the needed domain concepts identified on the port and/or the current activities
b. Recommend and provide information from subgroup visiting the port to other subgroups or group members
c. Recommend checking some domain concepts missed by students or subgroups on the port.

The p-IBST proposes also another functioning mode called the pull mode where the group/individual searches for information, activities, learners or tutors. Thus, the groups "write queries" to express their specific needs to obtain the relevant resources according to the current situation.

The pull mode may be used at different steps of the original scenario. A query filters concepts, resources, activities and persons. For example:

a. Write queries on relevant domain concepts like "crane", "bridge", etc. according to the current context (activities and localization), on retrieved information from other group members or subgroups according to activities and/or localization

To achieve such type of scenario, it is necessary to retrieve entities (information, documents, persons, etc.) in different tools distributed on Internet. Unfortunately, learning management systems and social media applications are data silos. In other words, data are unavailable on the web. Only people may have access to data, not computers. Reuse and exchange of data among LMS and social tools are only possible by means of API – that is to say manually by mean of one API per tool. On the contrary, semantic web provides a common framework that allows data, information and knowledge to be shared and reused across applications, enterprises, and community boundaries. In such a framework, linked data describes a method of exposing, sharing, and connecting data, information and knowledge on the Web (Bojaars, Breslin et al.

2008; Gruber 2008). It provides a standardized, uniform and generic method for data discovery, distributed queries against several data repositories, integration or semantic mash-up, uniform access to metadata, data, information and knowledge.

To manage such type of scenario it is necessary to manage models at semantic levels (ontologies). For instance, we need to design: a scenario model, a recommendation model, a context model (including a user model), a domain model and a resource model (a metadata schema). These models enable us to have common vocabularies to ensure exchange, reuse and sharing of resources. The domain and resource models are used to index resources. Some metadata can be generated automatically (sometimes on the fly) from the tool databases according to common vocabularies like Dublin Core, SKOS, SIOC, FOAF, OPO, etc. Most of these vocabularies are lightweight ontologies that can fit well database schemas.

IV. Conclusion

A major challenge for future technology-enhanced learning systems is to combine the benefits of learning management systems, personal learning environments, social media software and pervasive learning environments. As shown in the pervasive IBST scenario, semantic recommendations can help students to solve their problems and to enhance collaborative learning in situation.

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