A collaborative pervasive IBST scenario with semantic facilities

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Abstract. Web2.0 is becoming mobile and even pervasive. This offers new opportunities for learning, by enabling new collaborative situations for learning. Developing new learning environments for such situations implies to integrate activities in open architecture and identify candidate scenario jointly. In this paper, we propose a collaborative scenario for History of Science and Technology and teaching approach based on Inquiry. Through this scenario, we identify pedagogical activities, candidate tools for working on them, and facilities that could be provided thanks semantic analysis of the student work.

Keywords: Collaborative learning, pervasive learning, web 2.0, semantic web, IBST.

1 Introduction

Nowadays, technology-enhanced learning systems can be built on learning management systems (LMS) or personal learning environments (PLE). LMS provide administrative services. LMS are pre defined and the corresponding pedagogical approaches are implicit and frozen. PLE are distributed, personalized and composed of separated tools, social media applications (Web 2.0). 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.

Web 2.0 provides many different tools, with different specific features and objectives. Users typically mix different tools to achieve their activities. Use of different tools may lead to spread information over different environments. Two strategies are possible. Whether one may propose an integrated environment, like a Learning Management System (LMS) in order to avoid dissemination of data, or propose ways to relate information along the web. Choice between those two options is a matter of design choice [1]. While the former fosters consistency, the latter enlarges opportunities and may ease the work of digital natives. 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 [1].

Pervasive learning is an important issue in technology-enhanced learning field. Pervasive learning systems (based on pervasive computing) have 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 for supporting different aspects of the learning process [2]. The integration of pervasive facilities will enable new learning opportunities including outdoor activities [3]. Social interaction in such context makes necessary the interoperability of data across tools.

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. 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 means 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.

Our viewpoint is that future pervasive learning environments will be based on contextual adaptation 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. To specify future architectures to support such learning activities [4], one need to identify rich learning scenario. Thus, 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. Examples of such scenario can be found on the web[1].

We shall explore needed functionalities and adaptation to ensure data gathering, notification and sharing. The objective is to guarantee seamless access to information across tools to enable effective collaboration in groups and to enhance tutors' activities.

In this article, we aim at proposing a collaborative and pervasive scenario, where semantic facilities may ease the learning process. We firstly describe an existing IBST scenario. Then we examine how collaborative and pervasive tools can enhance learning experience, involving mobile and distant collaboration. Then, we identify tools families that may be used during such scenario, according to needed activities and expected results. Next we explore inter tools facilities needed to guarantee seamless collaboration. Finally, we cover models issues needed to integrate semantic facilities.

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[1] see for example at http://plates-formes.iufm.fr/ressources-ehst/spip.php?rubrique17

2 IBST Collaborative 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[2] and the publication of the Rocard Report [5] about a “renewed” Science Education where recommendations promoted an evolution of teaching methods toward Inquiry Based Science Teaching (IBST). Inquiry Based Science teaching may be defined by 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")

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”[3]. The work package 5[4] was dedicated to the role of ICT in IBST [6], [7]. 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 [8]. A Mind the Gap workshop was held in Brest in March 2010 about this topic[5]. In a more general point of view, this question of the role of history of science and technology in science education concerns the community of the historians of science in France[6] and in Europe (as it is shown by organizing symposium in the International Conferences of the European Society of History of Science since 2006[7]).

As results of the research studies, a HST-IBST website was created[8]. 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

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[2] see the FP7 “Science in Society” program at http://cordis.europa.eu/fp7/sis/about-sis_en.html

[3] http://www.uv.uio.no/english/research/projects/mindingthegap/about/index.html

[4] http://www.uv.uio.no/english/research/projects/mindingthegap/Deliverables/index.html

[5] http://pahst.bretagne.iufm.fr/?p=84 (European Workshop Mind the Gap “History of Science and Technology (HST) : ICT Resources And Methods for Inquiry Based Science Teaching (IBST) , Brest, March 18th-19th 2010)

[6] see for example the research activities of the french group named ReForEHST : http://plates-formes.iufm.fr/ehst/rubrique.php3?id_rubrique=28

[7] http://taller.iec.cat/4iceshs/documentacio/Draft01.pdf

[8] http://plates-formes.iufm.fr/ressources-ehst/spip.php?rubrique17

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 and it is composed in three parts/problems with the following objectives:

- Problem 1: to understand the industrial landscape in the area of the bridge (Brest is a shipbuilding arsenal for the Navy)[9]
- Problem 2: to understand what is the historical and technological method of problem solving that led to the construction of the swinging bridge[10]
- Problem 3: to understand the rotating mechanism of the swinging[11]

In this paper, we focus only on the problem 1. The first original scenario is as follows: Historical reading and understanding of an industrial landscape Instructions: From a walk up the Penfeld from Lift Bridge Recouvrance (meeting place on the parking lot of the Tour Tanguy) and by relying on the gathered historical information before the visit about cranes, bridges and views of the arsenal, you must:

– photograph all elements of the current landscape with historical aspects about cranes and bridges of the arsenal,
– locate the different elements on a current map of Brest,
– identify and photograph the actual bridges and cranes linked existing bridges and cranes from previous: what continuities ? What ruptures?
– store and publish information on the corresponding tools.

In this case, the students were in-service teachers. Three notebooks (with historical pictures)[12] about cranes and bridges, the industrial landscape in the arsenal of Brest and maps of the port were printed and distributed to the students before the trip. 4 groups of 3 teachers were constituted and every group received a digital camera. The teacher trainer went with the groups. He interacted with the students in order to give advices, guidance and answers to queries all along the walk on the site to be explored. After the return in the classroom tooled up with PC and Internet connection, each group stored and published on a Google site the pictures taken during the walk.

By discussions guided by the trainer, the next session (in classroom) was devoted to the exploitation of the corpus of pictures in order: i) to analyze the continuities and the rupture observed in the history of the industrial landscape; ii) to understand the historical context and the industrial environment in Brest of the swinging bridge. The session ended by the institutionalization of the knowledge by the trainer.

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[9] http://plates-formes.iufm.fr/ressources-ehst/spip.php?article17
[10] http://plates-formes.iufm.fr/ressources-ehst/spip.php?article18
[11] http://plates-formes.iufm.fr/ressources-ehst/spip.php?article24
[12] http://plates-formes.iufm.fr/ressources-ehst/spip.php?article17

3 IBST collaborative and pervasive scenario

The scenario defined in the previous section provides interesting activities, including site exploration, data publication on the web, and collaborative knowledge construction. However, it may be revisited with mobile and collaborative web tools. In this section, we propose some enhancements of existing scenario, which enhance learning experience, by providing tools that enable constant access to information and real-time collaboration among work group, even when working in different areas.
For refining, the previous scenario, we adopt a classical Problem-Based-Learning approach, giving us a generic sequence of activities. In this sequence, we start to identify some points where information tools would be relevant, or even essential.

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). 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 sub-group visits the historical site to gather geographical information, photos, and to relate historical information with modern site architecture. The other sub-groups search for additional information in the navy museum and the local public records. 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.

According to this scenario, we propose web tools that allow real-time sharing and access to information. Such a scenario combines group activities, information gathering, communication with mobile, mobility and geo-localisation, working with maps, simulation, collaborative and cooperative activities, collaborative writing, etc.

Additional collaboration could be added to provide inter-group exchange and/or peer assessment:

- Groups may share collected information, ensuring that no group (or all) is missing crucial information,
- Peer reviews at different steps, may help a group to sharpen its analysis and to get useful hints,
- On the teacher side, other activities are to be considered to complete the information system:
- Group tutoring, which may be analyzed thanks identification of collaboration, cooperation, hypothesis and tracks explored.
- Individual tutoring, which may be facilitated with work trace analysis, or relevant activity indicators.

All those information, which may be used for tutor guidance or final assessment, are proposed to the students as self-efficiency indicators, and for peer review or assessment.

In the next section, we define generic activities that should be supplied with tools, corresponding tools family that are relevant to this scenario, and content produced during those activities.

4 Tools according to activities

In the following table, we relate activities, tools families, and possible content produced. One may notice, according to the previously defined scenario, that content produced during an activity will be used in a future activity.

Table 1. Relation between activities, tool families and content types.

Activities	Tool families	Content produced
Searching information	Search engines, Social book-marking Blogs, Wikis, etc.	Shared bibliography Annotations, Notes, images, videos, etc., potentially geo-localised.
Site visit	Smart terminal with Camera, GPS and Content Management Systems (CMS).	Geo-localised text, pictures, videos.
Group communication	Chat, Microblogging, Voice, Video, etc.	Real-time information sharing for work group coordination.
Collaborative Collected Data analysis	Maps Any tool for idea exploration such as Mind map tools.	Knowledge restructuration
Collaborative Report writing	Shared bibliography Annotations, Notes, Images, Videos, etc. and Collaborative Writing Tools	Final report : knowledge construction
Peer assessment	Collected Group work	Quality analysis, Hints, Rating based on an assessment scheme

Content produced in every activity may be done by different people using different tools. However, the needed work information is a synthesis of all collected and produced content.

Considering search of information, synthesis would be a data organisation (classification, mapping, etc.) and relevant keywords or tags (as concepts) among tools. The result of the cooperation between the site visit and the museum visit should be an aggregation of geo-localised data on maps. As a tutor, or a learner, one may want to enhance collaboration among people on different communication tools concurrently, whether to get a view on current learner work, or to synchronize collaborative work across tools.

5 Needed integrated views among tools

A Pervasive Learning Environment should propose integrated views with loosely coupled tools. Those tools could be chosen on-the-fly for efficiency or personal preferences, and should integrate all web available tools. Consistency is important for students for retrieving manipulated data, and for teachers as well for having a view on work achieved to enable better interaction with the students. Enabling tools choice and ensuring consistency have therefore to be ensured. Integration of all available tools should enable data retrieval among tools in order to allow data sharing and real-time interaction across tools, in order to allow effective collaboration. Data sharing implies: reusability of resources and personalisation in different tools, relevant data retrieval across tools, common interpretation of data.

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. 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. 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.

6 Required Semantic models

Our system needs to deal with different tool families (bookmarking, blogs, forums, wiki, etc.) and devices (mobile devices) to promote such collaborative learning scenarios. Some issues are:

– The re-usability of resources produced by different learners and groups using asynchronous tools or devices. Moreover, the reuse of learning resources requires interoperability at the semantic level;
– Several versions of resources are required for different tools and devices to meet the different conditions of reuse or to ensure a personalization for the learner's task realization in an open architecture;
– The transparency of knowledge sharing through learners who may have not the same interest, using tools, devices, learning tasks, etc.;
– The relevance of information retrieval that is a semantic search which needs provide relevant contents according to learning requirements. In other words, how to ensure the relevance of information gathered or collected during learning process by different learners or groups and in different tools, according to a learning topic.

One of the reasons for the semantic web is to solve these problems of finding information by avoiding polysemy and reducing the number of results. In other words, the objective of the semantic web is to improve access to information to make it reusable and shareable by all actors whatever being human or machines, which then allows the automation or semi-automation of certain tasks and thus creating intelligent services. By this way, the semantic web will answers our requirements about seamless access to learning information across tools, devices and therefore enrich collaborative learning activities between learners. That is because the semantic web offers tools and infrastructures for semantic representation by means of ontologies. The latter foster the sharing and interoperability of model concepts by the way that provides a single semantic representation for each concept. In our approach, four models are used: domain model, scenario model, user model and context model [9], [10].

- Domain model: defines a set of concepts, tags and their relations providing a knowledge base about a specific learning domain of interest (i.e. History of Science and Technology), which the learners need to acquire during learning process. When resources - produced in different tools and learners - are indexed by these concepts, the system then can easily find all resources relating to these ones across tools and devices. To have this done, it is necessary that these tools have the capability for the learners to access domain concepts and tagging learning resources with the latter.
- Scenario model: the main goal of this model is for the tutor, teacher and learner to organise their learning activities in different levels: the teacher or tutor can assign learning tasks to learners and groups, a learner can plan activities for himself, or learners in a group can describe collaborative activities between them and groups. A scenario can be represented using a hierarchical task model [9]. The scenario model can be divided into three levels. In the first level, the learning activity typology that is composed of learning activity categories and sub categories. In other words, a category is a specification that can be instantiated or reused in the second level for describing scenarios. The third level represents the status of learning activities across tools, devices, platforms, etc. This level presents the learners' history.

- User model: this model will provide a common structure for user (learner, group) characteristics and their relations to cover as possible to the user's information in different tool families. For this reason, we mainly combine the SIOC[13] and FOAF[14] ontologies to represent our user model. While SIOC ontology enables to describe social communities and their relations through blogs, forums, wiki, etc. The FOAF ontology supplements the SIOC ontology by focusing on the links between users in those communities.
- Context model: the goal of this model is to provide contextual information that enables the learner to describe their learning situations and relate resources with that information, one can make the system more context-aware. For example, a learner can link resources produced outdoor - especially, in a mobile situation - to his current geographical location, used tools and devices. He can also share the information about his current location with other learners in the group, etc. Also, the system can recommend the relevant resources to the learner according to his current situation (location, device, etc).
- Meta-data model: it provides a common schema to index resources by means of a set of structured features. Some of them use the domain model. Moreover, 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 of social tools.

These vocabularies provide common semantic enabling computers and people to put queries on LMS and social media tools. Thus, the web can be viewed as a single global database. Users and/or computers can perform complex queries against this global database using the SPARQL language. Complex queries are queries over multiples pages, web sites and data repositories whatever the tool is. It only has to expose data on the common standard and vocabularies.

7 Conclusion and future works

In this paper, we propose an IBST scenario, proposing collaborative activities that require different tools and make usage of different media data. This scenario combines mobile exploration and collaborative use of data for problem solving. We identified some need of information retrieval that are not achievable with existing tools and necessitate some post processing in the cloud learning environment defined on-the-fly. We have shown that semantic web is a promising technology to ensure those posts processing, to enable a truly open learning environment that can be defined by the students themselves, whilst providing seamless integration, supervision and collaboration across tools.

Our future work will consist to enable such semantic-based consistency among existing tools and test it during real courses. We propose ourselves to construct a

[13] SIOC Core Ontology Specification: http://rdfs.org/sioc/spec/
[14] FOAF Vocabulary Specification 0.97: http://xmlns.com/foaf/spec/

prototype based on a subset of web2.0 tools, as a first step, to clarify effective models used.

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