Digital Design with KP-Lab

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Abstract—**KP-Lab is an EU Integrated Project envisioning a learning system that facilitates innovative practices of sharing, creating and working with knowledge in education and workplaces. The project exploits a novel pedagogical view, the knowledge-creation metaphor of learning. According to such "trialogical" approach, cognition arises through collaborative work in systematically developing shared "knowledge artefacts", such as concepts, plans, material products, or social practices. The paper presents the plan of a pilot course to test the KP-Lab methodologies and tools in the field of Digital Design.**

Index Terms—**Applications of the Semantic Web, Platforms and authoring tools, Tools for interactive learning and teaching.**

I. ENGINEERING EDUCATION TODAY

In spite of the recent hype on new educational technologies and their potential for a novel approach on learning and acquiring knowledge, university education has remained the same that it has been since the first universities have been established, many centuries ago. The transmission model is still dominant and now, as in the Middle Age, students of higher education take many years in acquisition-oriented and teacher-centered studies. Technical education at a university level has a different history, since the first engineering schools in Europe were established only during the nineteen century. For example, the origins of our institution, the University of Genoa, go back to the thirteen century, while its first technical school, the "Royal Naval School" has been established only in 1870. Before the diffusion of formal engineering studies, the engineers got their training outside a classroom, usually by joining a community of people already engaged in the exercise of the profession, acquiring and sharing knowledge, information, processes and practices. A natural and deep learning resulted from the deep interaction among people themselves and among people and the objects of their practice.

The accelerated rate of technological innovation, brought about by the industrial revolution, showed the limitations of this ageless mode of learning and prompted the birth of formal technical education. An engineering school is, in fact, more effective in transmitting knowledge at a fast pace and in providing the stronger theoretical background necessary for the new technologies.

An unwanted casualty of this process has been, unfortunately, the active learning mode typical of the former education. Engineering curricula are able to adjust their contents to support the new technologies, but are still based largely on frontal lectures, assembled into courses that provide fragmented pieces of knowledge and skills. There is hardly any explicit continuation from one course to another. Today's engineering curricula, therefore, embody in large part the paradigm of instructional, transmissive pedagogy and often fail to provide the right competencies to solve the complex problems of professional life.

A. Network-Based Project Learning

The development of information and communication technologies has brought profound changes in work methods and processes. More and more tasks are accomplished in a collaborative way, often by geographically distributed teams. These new working methods require proper training and new skills, like the ability to work cooperatively in virtual environments. In the field of education the Internet revolution has provided a strong stimulus to reintroduce active learning modalities in engineering education.

As an example, the NetPro project [1,2] has integrated Problem Based Learning with Internet-based methods and tools, extending its application from a classroom to a wide, geographically delocalized environment. The result, Network Based Project Learning (NBPL), is a teaching/learning model that involves students in problem-solving tasks, allows students to actively build and manage their own learning, and results in students-built realistic deliverables. The underlying principle is the assumption that learning occurs during these unstructured, complex activities. The NetPro experience has been very significant for the authors, establishing the validity of the approach and the interest and will to further develop it by taking advantage of new and emerging technologies. The same team that contributed to develop and pilot NetPro in our institution is now engaged in a new project that, building on the previous experience, (cooperative work, distance work etc) explores a new, advanced approach.

II. THE KP-LAB PROJECT

The "Knowledge Practices Laboratory" (KP-Lab) [3], an Integrated Project sponsored by the 6th EU Framework Programme for Research and Development, aims at creating a learning system that facilitates innovative practices of sharing, creating and working with knowledge in education and workplaces. The project's partners come from research communities active both in the pedagogical and technological domains.

The project builds on the idea that beyond the metaphors of learning as a process of knowledge acquisition (monological, within mind approach) or of participation in a social community (dialogical,

interactive approach), there are central theories concerning learning and human cognition which do not fit within these distinct categories. These theories are a basis for a third view involving what the project calls the knowledge-creation metaphor of learning (trialogical approach). According to it, cognition is seen to develop through collaborative work in systematically developing shared, conceptual or material artefacts, such as concepts, plans, products, or social practices.

The project promotes co-evolution of individual and organizational learning with technology through the development of a learning system based on technological, theoretical, pedagogical, and social innovations aimed at facilitating innovative practices of working with knowledge ("knowledge practices") in education and workplaces.

A. KP-Lab Tools

KP-Lab is developing, by taking advantage of the new generation of web technologies, a cluster of inter-operable applications, which include:

- a virtual collaboration space;
- common tools for working with knowledge artifacts and for managing knowledge creation processes [5, 6];
- specific tools that facilitate the discovery and exploitation of tacit and practice-related knowledge;
- shared multimedia annotation tools;
- ubiquitous cooperative conferencing and communication services;
- semantic web knowledge middleware for learning applications.

Fig. 1 shows a screenshot from the beta version of the KP-Lab Portal main page that has been released in February 2007. The user can register and login by username/password fields in order to enter the portal. Once logged in, users can explore their working environment.

The Shared Space (SSP) browser lists all the SSPs that the user can participate to; in Fig. 2 the"Digital Electronic Design" is depicted. The info tab, on the right, gives basic information (metadata fields) on the SSP. Several actions can be activated by right-clicking on the SSP: enter Shared Space, show item's info, add link, start discussion, add comment and others.

A SSP can be represented by different views. They are: (1) process view, where a GANTT chart shows the scheduling of the course tasks, (2) a content view, which focuses on contents, links between tasks and contents, and between contents themselves, (3) a community view that shows the members of the selected SSP.

In Fig. 3 the "Digital Electronic Design" SSP has been opened and shown as content view. From now on, the actions taken by the users affect the specific SSP.
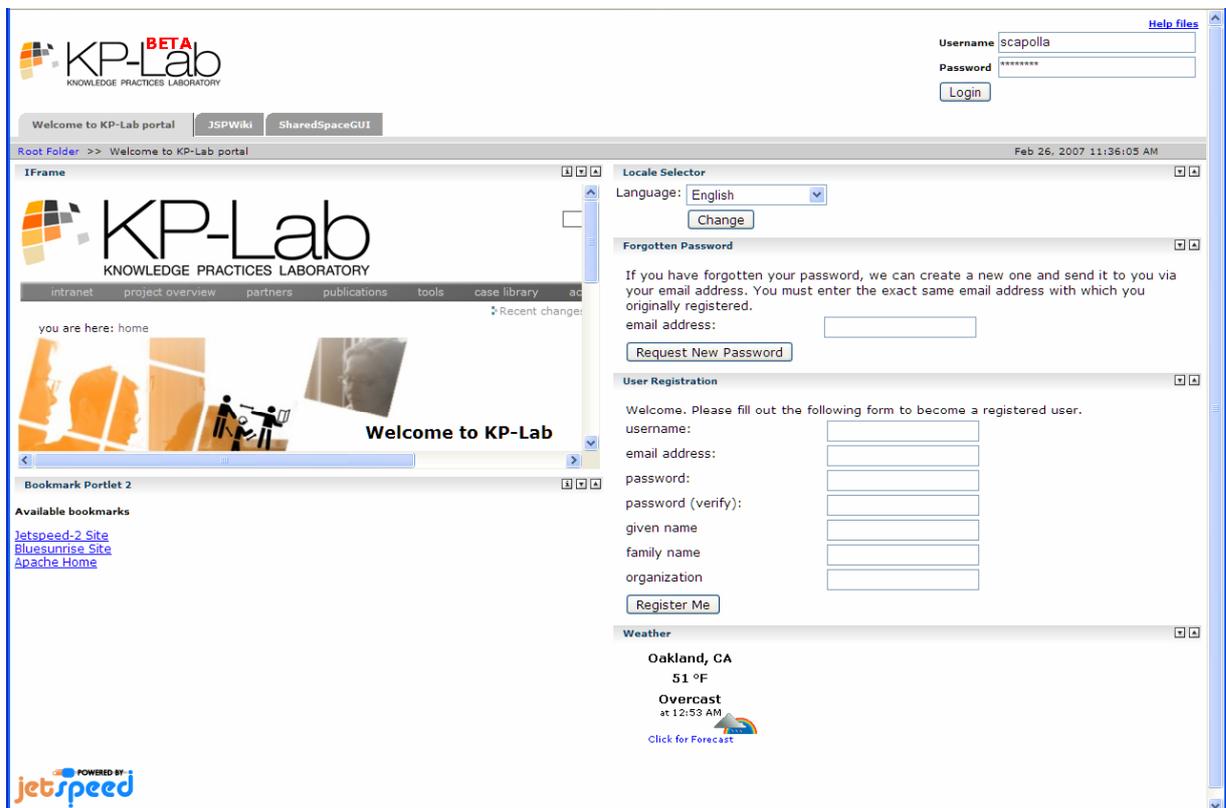
Figure 1. KP-Lab Portal (beta version)
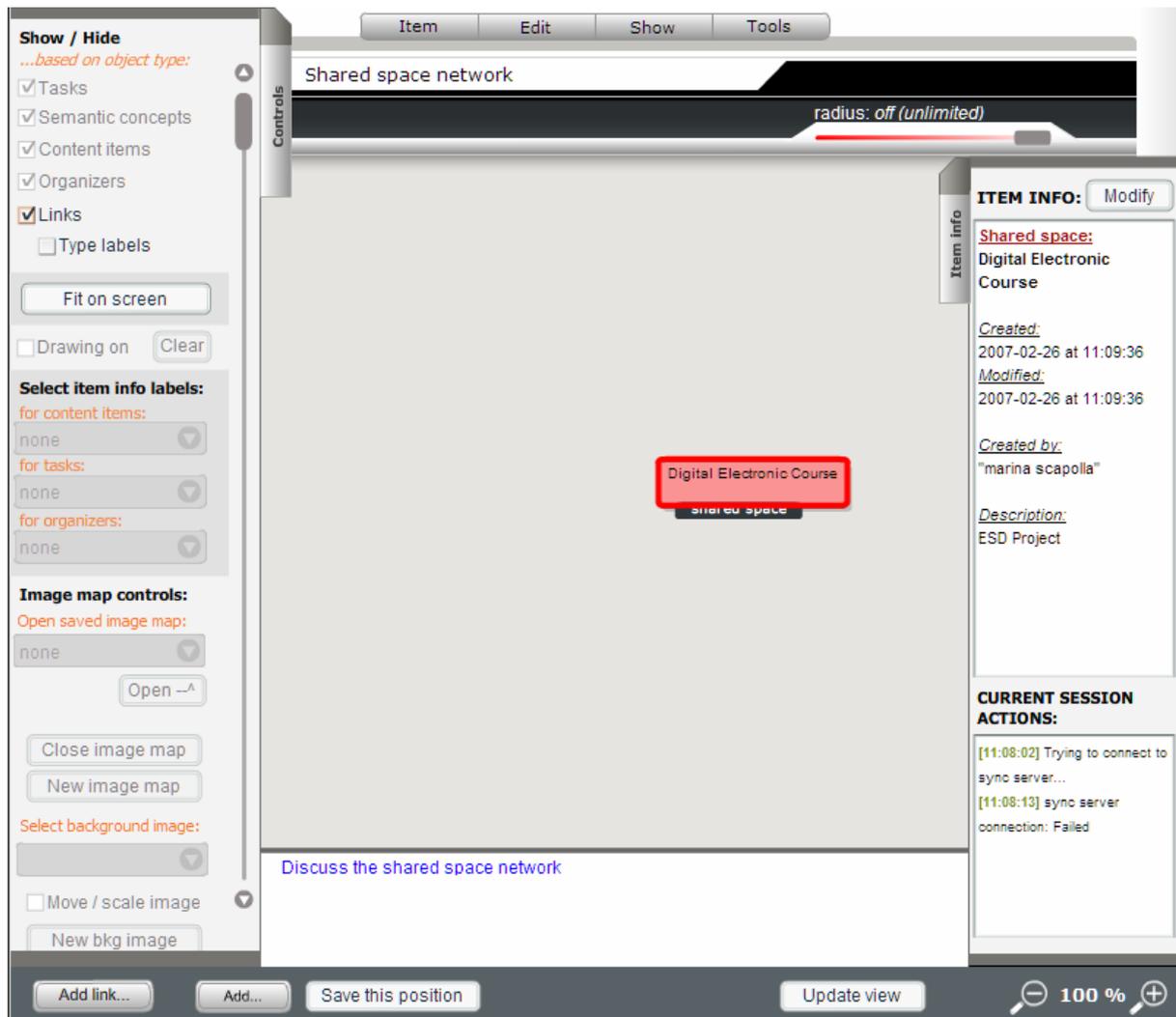
Figure 2. The Shared Space browser

Users may add content items to the system and drag them around the view area. A dialogue box allows to choose the type of content item and to fill in some pieces of information, such as the name of the content item and of the responsible person, and a description of the content itself.

Available content types are : Wikipage, File, Link, Discussion (all of them are present in the SSP of Fig. 3 with their specific icons). The "type" in this context does not limit the file-type that is being uploaded, it is just a way to ease filtering and searching when there are several more objects being visualised within a view in the SSP tool. There is the possibility of selecting more than one participant to be responsible for a single content item. This may be relevant from a pedagogical or organizational point of view.

It is possible to choose (left menu in Fig. 3 the object types to show or hide in the view. The content item in the SSP tool is only a link to a document that has been uploaded to the system. When a content item is opened, it would not be opened within the SSP tool, but rather by the proper external application. Some metadata or item info is always available directly in the view area. An example of such information could be the creation date and the author. Each content can be commented

("annotated") by a free text. The annotation looks like a "Post-it"-note that is stuck to the node.

Nodes of the SSP can be linked by hierarchical or relational links. Any object belonging to the SSP can be commented (see the "post-it" icon close to task and content boxes in Fig. 3).

Moreover, it is possible to add semantic concepts from a pre-defined vocabulary. The list of semantic concepts is based on an ontology created by the teacher of the course or could be one that has been created by an expert and is being used by the teacher for this course. Semantic concepts can be linked to the SSP nodes.

III. THE PILOT EXPERIMENT

We are designing a pilot course to test the KP-Lab methodologies and tools in the field of Digital Electronic Design. The aim of the pilot is the same as of the traditional class it replaces, i.e. to provide a solid background on the fundamentals and, at the same time, meaningful problem-solving and design skills. Fig. 3 shows a very preliminary attempt to build a SSP for the course.
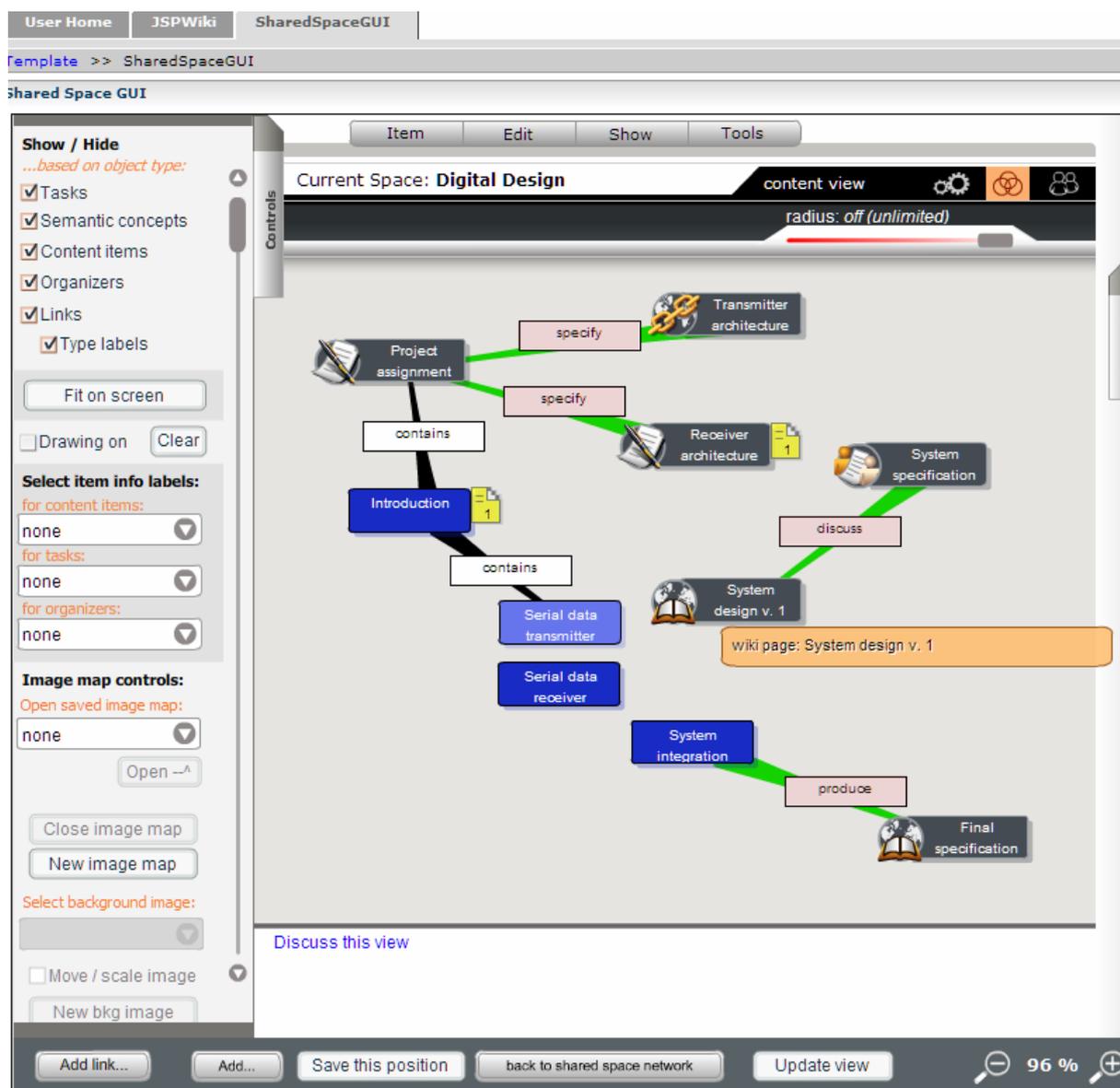
Figure 3.   Digital Design Shared Space content view

A typical project will start discussing and annotating the functional specifications of a digital system to develop.

There are "tasks" (shaded rectangles without icons) and "contents" of different types (as indicated by the proper icons). For example, the project assignment is a content file stored in the KP-Lab repository, while part of the project's system architecture is provided as a link to the URL of our existing repository of digital projects. The documents that need to be prepared through collaborative work, such as the final system specifications, are wiki pages.

While executing the tasks, the students will interact among themselves through the objects of their activity (called "knowledge artifacts" in the project's terminology), represented in our case by the system schematics, ASM charts, timing diagrams etc. Students will have access, in addition to KP-Lab tools, to discipline-specific tools [7] that are necessary for the understanding and development of the projects, such as circuit design and simulation tools.

IV.   CONCLUSIONS

In our opinion, KP-Lab represents a bold attempt to take advantage of new educational theories and advanced ICT tools for building a novel model of learning and developing knowledge. KP-Lab is traveling an uncharted land and difficulties, both on the technical and pedagogical points of view, are expected. In some extent, the project aims at using such problems to adjust ("co-evolution") its targets and procedures.

The high ideals inspiring KP-Lab may find a very difficult application to the reality of today's teaching and learning. Our pilot will certainly be a tough test for the project. The large number of students following our traditional class can be difficult to deal with in a KP-Lab approach. It seems obvious that the class should be

divided into groups, with separate SSP. As a consequence, there will be the necessity of managing many projects running in the same time span. It is not easy, at the moment, to estimate the workload of teachers and assistants.

The biggest challenge for KP-Lab, though, is, in our environment, its acceptance by students and teachers. Without mentioning, of course, the huge problem of finding out a student evaluation method that would be consistent with the pedagogical approach.

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