

INTERNET BASED PROJECT LEARNING FOR ELECTRONICS

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ABSTRACT

Project Based Learning (PBL) is a widely used pedagogy in engineering education. The NetPro project integrates traditional PBL into a network based learning environment. The project has developed models, tools and services to facilitate communication and collaboration between distant students, and to manage access and control of project deliverables. NetPro project teams form cross-institutional learning communities. This new learning environment is a distributed system that facilitates sharing and peer reviewing of project deliverables and interaction in special interest group discussions. NetPro methodologies and tools have been developed and tested by running pilot projects: four streams of pilots have been run during the project life. The paper provides a few details of the pilot course on Electronic Systems Design. To accompany the tools, the NetPro project has built a Web based collaboration environment, the User Community, to support teachers, trainers and course designers in using models, materials and tools efficiently.

1. PROJECT BASED LEARNING

The maturation and diffusion of e-learning technologies has raised the hope for the development of learning methods and infrastructures more adapt to develop the skills needed in today's workplace. Major efforts have been put on the development of web-based virtual learning environments and tools for education and training [1]. However, most of the products and tools available are still based on classical pedagogies. Their main functionalities are the management and distribution of learning materials, synchronous and asynchronous communication, and progress tracking and reporting.

In the meanwhile, the development of information and communication technologies has changed work methods and processes in the field of engineering. More and more tasks are accomplished in a collaborative way, often by geographically distributed teams. These new working methods require proper training and appropriate skills, among which is of paramount importance the ability to work in virtual environments.

Educational institutions in the field of engineering have certainly made efforts in the direction of updating their courses and contents to support the new technologies. Unfortunately, they did not apply a comparable amount of efforts in the parallel task of adjusting the ways and methods of the educational process itself.

Curricula, indeed, still based on courses, provide fragmented pieces of knowledge and skills. From a methodological point of view, it is clear that the paradigm of transmissive, instructional pedagogy, focused in the student-teacher interaction, is still dominant.

Project Based Learning (PBL), a common form of collaborative pedagogy in engineering education, 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. Students work on concrete tasks and produce realistic products. The underlying principle is the assumption that learning occurs during these unstructured, complex activities. Ways of implementing and using PBL are diverse and multiple. They differ by the complexity of the projects, their combination with classical lecture-based

methods, the role of the teachers and students in planning these projects, and the group or individual approach. Teachers and students activities in PBL context are different from those in classical pedagogies.

2. NETWORK BASED PROJECT LEARNING

The innovative approach developed by NetPro integrates traditional PBL into a network based learning environment. The NetPro framework provides process models with specific project learning phases and actors with their roles, methods for collaborative learning, resources to support project implementation, and tools to build a Web-based learning environment that supports project learning.

In Netpro, a project is considered as a course. Teachers define the objectives, content, activities, working method, tasks, deliverables and assessment strategy of the project. A project is divided into tasks, each task consisting of certain activities and resulting in creating deliverables. Learning materials, guidelines, and templates that help students to complete tasks are provided. Students are organised into groups and every group carries out a project. Pedagogical activities such as peer reviewing, group discussion, peer coaching and self/peer assessment can be set up by teachers to enhance the learning effectiveness of the project. Groups of students plan their work, complete the scheduled tasks, and produce deliverables. A deliverable can be any kind of document (e.g., engineering design, progress report...) or other products (e.g., software programme). These deliverables are shared with their peers locally or in an international learning community. Groups are asked to review work produced by their peers working on similar topics and provide feedback to authors. This activity is done using guidelines created by teachers and result in filling-in peer-review questionnaires that depend on the nature of the deliverable and the topic. Discussion forums between reviewing and reviewer groups allow them to justify decisions and explain feedback. This allows students to develop a good judgement of quality and to learn from the errors and experience of their peers. Peer coaching is another activity being experimented. Senior students act as coaches for junior. They provide them with assistance and support during the project work.

3. THE NETPRO PROJECT: TOOLS

In order to implement the PBL approach described above, NetPro developed a set of tools targeted at the students and teachers. They allow teachers to manage project work and students to complete their project learning activities. These tools are organised in a database application accessible from the web.

The teacher tools allow the creation of new projects, by providing the following functions

- o Create, delete, modify a project structure (called project deliverable centre: PDC)
- o Define tasks and deliverables for a project
- o Create, delete, modify student groups for a given PDC
- o Provide groups with work space and communication tools
- o Link guidelines, templates, learning materials to tasks and deliverables
- o Link peer review guidelines and forms to deliverables and tasks
- o Assign groups for peer review
- o Set up peer assessment scheme or view its results
- o View work progress for all groups
- o Create discussion forums
- o Set up peer coaching

The student tools allow the following activities:

- o Visualise work progress table (called PDC table)
- o View guidelines, templates, learning materials related to tasks or deliverables
- o Edit group details
- o Upload or link finished deliverables
- o Download or view other groups deliverables
- o Fill in a peer review form to give feedback to peers
- o Take part in a discussion forum
- o Jointly edit a document with group members
- o Seek peer coaching and communicate with coach

Project	Help	001	002	003	004	005
		Info Email	Info Email	Info Email	Info Email	Info Email
Deliverable 1	?	03-12 😊	03-12 😊	03-12 😊	03-12 😊	03-12 😊
Deliverable 2	?	03-16 😊	03-16 😊	03-16 😊	03-16 😊	03-16 😊
Deliverable 3	?	03-23 😊	03-23 😊	03-23 😊	03-23 😊	03-23 😊
Deliverable 4	?	03-30 😊	03-30 😊	03-30 😊	03-30 😊	03-30 😊
Deliverable 5	?	04-06 😊	04-06 😊	04-06 😊	04-06 😊	04-06 😊
Deliverable 6	?	04-18 😊	04-18 😊	04-18 😊	04-18 😊	04-18 😊
Deliverable 7	?	04-27 😊	04-27 😊	04-27 😊	04-27 😊	04-27 😊
Deliverable 8	?	05-04 😊	05-04 😊	05-04 😊	05-04 😞	05-04 😊
Deliverable 9	?	05-11 😊	05-11 😊	05-11 😊	05-11 😊	05-11 😊
Deliverable 10	?	05-18 😊	05-18 😞	05-18 😊	05-18 😊	05-18 😊
Deliverable 11	?	05-25 😊	05-25 😞	05-25 😊	05-25 😊	05-25 😊
ISILAB	?	06-01 😞	06-01 😞	06-01 😊	06-01 😞	06-01 😞

Fig.1: The Project Deliverable Center: “student view” of an electronic project.

4. THE CORE TOOL: PROJECT DELIVERABLE CENTRE

The Project Deliverables Centre (PDC) is the core component of the tools. It has two primary purposes: to support knowledge sharing between students, and to ease the tutor's workload in high-level project management. PDC provides a convenient way for sharing all the public project documentation within the learning community.

The main view of the PDC is a graphic that shows which items have been delivered, using a coloured-smiley metaphor (Fig.1). The course supervisor, using the Admin view, can create, modify and delete project teams, and define deliverables with deadlines. As deliverable specific resources, the supervisor can upload guideline and template documents that are then

available in the student view. When a new student group is created, the system sends a computer-generated email to the student project manager giving the identity and password for access to their record, and other operational details. The teams may develop and maintain their own project site on a NetPro server, or produce their sites with any tools that are available for them and then link the public deliverables into the PDC by providing the URL. Another option, convenient for using PDC for managing reports of laboratory courses, where there is no need for project management and communication methods supported by the project site concept, allows direct uploading from the web. When this option is selected, no other web server is needed for storing the deliverables.

Students maintain the PDC by logging in with their group password. After logging in they can update their group's data, upload deliverables, and do specific learning activities specified by the course supervisor using the different card views provided. Reviewing other groups' work can enhance the learning experience of project students, for both the reviewer and the reviewed. After the designs have been completed and documented, the groups can do peer reviews. In this process they can observe different approaches to the same problems and evaluate their benefits and drawbacks, so that all the groups can learn from each other's work. The course supervisor creates on-line forms that the students use when doing the peer review. After the peer review form has been created and linked to a deliverable, the supervisor assigns the peer review responsibilities between teams within a PDC or between teams in different PDCs. It is thus just as easy to review the work of a group in a remote institution as it is within one's own site. After a deliverable has been published in the PDC, it can be peer reviewed simply by filling in the online form. Teams can access the forms, after logging into the PDC, by clicking the Peer review tab. The project teams can also easily access the peer review report made on their deliverable in the PDC Peer review view.

The NetPro learning environment also includes facilities for the students within a group to assess one another's contribution by awarding grades against a given set of criteria. The course supervisor can create on-line forms that the students use when doing the self and peer assessment. A form can be used in multiple PDCs and also shared by teachers. After the project is finished, the team members can do the self and peer assessment by filling in the form assigned for them. Each student can see whether their colleagues have completed this task, but the values awarded are concealed until everyone has done it. Supervisor can view the peer assessment results at any time. The view shows how the individuals have rated each other and also the figure for relative performance of each team member. It is then up to the supervisor to decide how to use these data.

Each project has available one or more open discussion spaces, called Special Interest Groups (SIGs). They are sort of bulletin boards where course participants can read and write messages. Messages posted on SIGs are public: every project member can read and reply to them.

5. NETPRO IN ELECTRONIC ENGINEERING

During the project's life, four streams of pilot courses have been organised to test and validate NetPro method and tools. They have run courses in the fields of Electronic and Software Engineering, Multimedia Authoring, Interactive Web applications. In the following we provide a short description of the Electronic System Design pilot course, i.e. the one organised and conducted by our institution.

The student projects in the Electronic Engineering pilot courses apply the NetPro methodology and tools in the field of education in electronics. The basic philosophy underlying their design and organization has been not to adapt our teaching to the

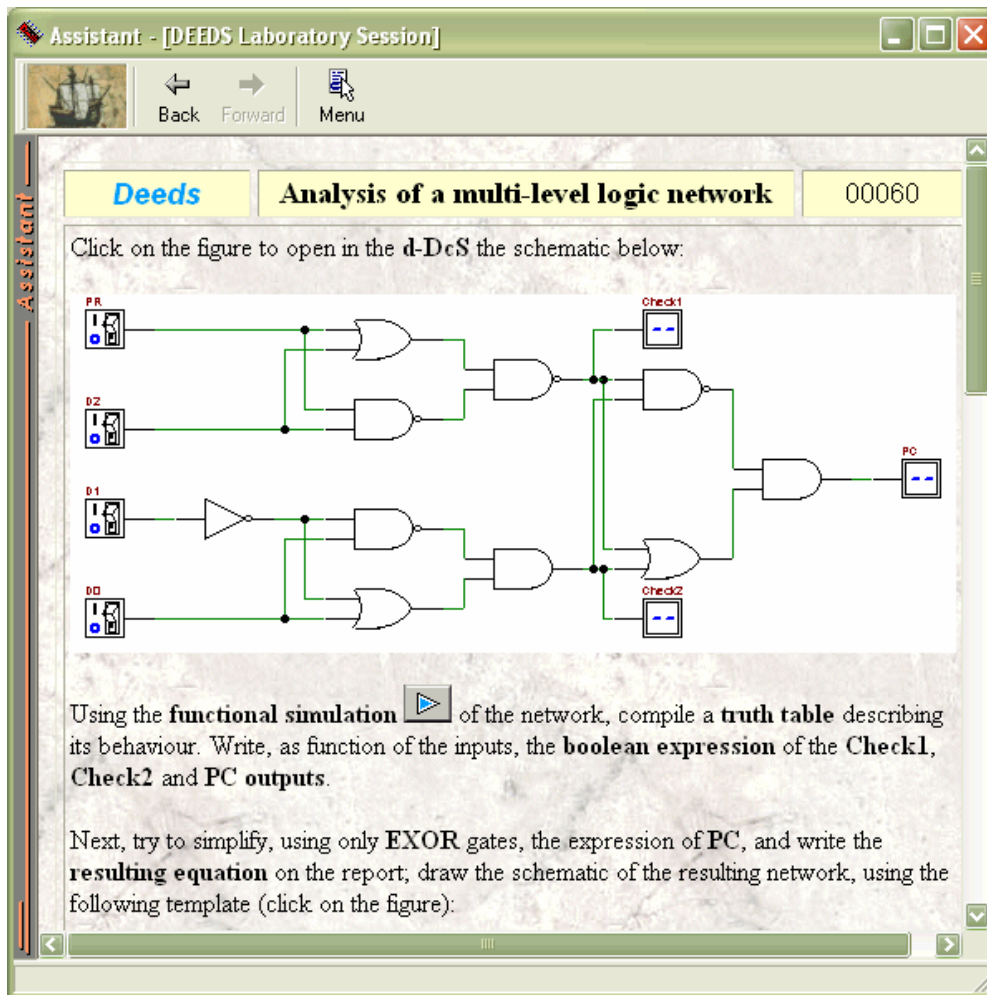


Fig.2: The Deeds “Assistant Browser” provides help and guidance to develop the projects.

characteristics of NetPro but, instead, to use it to fit our pedagogical needs. As a consequence of such approach, in order to accommodate different students’ levels, skills and motivations, we tried a wide variety of pilot course formats, from simple projects given as laboratory assignments to more complex tasks. Projects were designed either to serve as a support of a traditional course or to replace completely lectures with project-based activities. NetPro tools were used accordingly to the pedagogical needs, with the results that many courses did not employ the full set of project’s tools.

The organisation of a pilot course depends very much on its nature and level. Simple projects are designed to support introductory courses of electronics, usually by coordinating and following the laboratory activities [2]. These projects take fully advantage of the Deeds learning environment, developed specifically for digital electronics, which is described in another paper in this same conference [3]. Netpro provides a considerable help in streamlining the management of a large number of project teams, making totally obsolete the traditional paper delivery of laboratory reports.

The learning environment for digital electronics is built around three main components:

- o The Digital Electronics Education and Design Suite (Deeds)
- o Interactive learning material and solved problems for Digital Electronics
- o Internet Shared Instrumentation Lab (ISILab)[4]

After completing a project of the first kind the student is expected to be able to:

- o Design combinational, arithmetic and sequential digital circuits (the latter as Finite State Machines)
- o Analyse and test digital designs with the use of simulators
- o Understand the principles of electronic CAD (Computer Aided Design)
- o Use a remote electronic laboratory controlled through Internet

With Deeds, teachers can provide tutorial materials to support projects' development, in order to suit the specific pedagogical needs of their courses. In introductory level projects, the Assistant browsers (Fig. 2) are used to provide help and guidance to develop the projects. When students complete their projects, they public the assignment report (Fig. 3), delivering it through the PDC.

ISILab is a test and measurement bench composed of remotely controlled instruments through Internet. The purpose of ISILab is to introduce real-world (not simulated) laboratory experiences in the context of the NetPro projects. The device under test will be connected to the bench and therefore will be accessible to all the remote teams. The experimental set up can be distributed in different real laboratories, spread on a wide area network, and controlled by local computers. Users can carry out experiments through the network and practise transparently to the real locations of the devices under test in a multi-user concurrent way. More information on ISILab is available in [4].

More advanced projects [5] are organised to develop skills immediately usable in the real world, by stressing the use of professional design, simulation and synthesis tools and, at the same time, emphasising the cooperative nature of project work, strengthening the skills needed in project management, project documentation (definition, plan, report), and project communication (internal, external, face-to-face, Internet-mediated).

9. COLLABORATION BETWEEN PILOT SITES

An important characteristic of the pilot courses is that project groups can be distributed over different academic institutions and countries. A pilot course may have teams from more than one institution and more than one nation, while teams themselves could be inter-institutional and international.

The immediate goal of the collaboration between pilot sites is to provide learning tasks that are meaningful for all students, independently of their local arrangements. Obviously, a long-term result of such joint learning activities will be a further step of a most welcomed and long overdue process of integration and convergence of methodologies and programs within the institutions of higher education in the EU.

In fact, most European universities follow similar curricula in the engineering field so in principle it is possible to have joint activities. However philosophies, working practices, curricula and schedules at the partner universities differ considerably. The project has therefore identified common areas of subject matters in information technology and the pilot courses have been designed around them. Each pilot site is responsible of organising the project activities locally in the way that fits its curriculum and local teachers and tutors take care of the teaching related to the project. Pilot partners shared materials and methodologies and developed common guidelines, templates, peer review forms and other required materials for their projects. Groups of students from distinct partner sites engage in peer review and discussion activities.

Joint working is possible if teams use the same language (all the components of our pilots, including student deliverables and communication, are in English) and if the classes involved

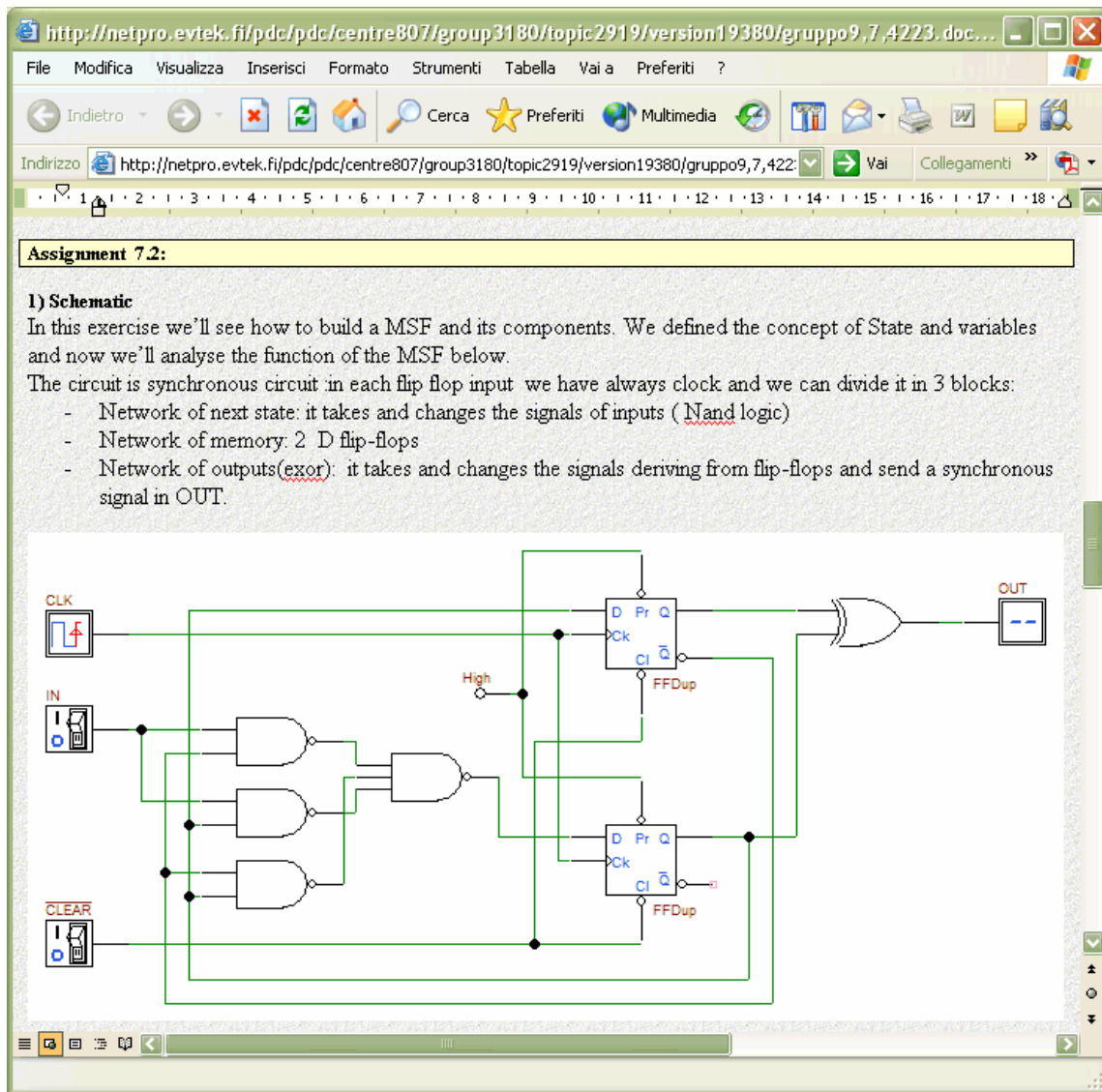


Fig.3: An example of student report.

study the same topic at the same time of year. Experience has shown that full cross-institutional co-operation as described above is difficult to implement and resting upon a series of conditions that are out of our control, such as timely uploading of deliverables. We were able, though, to share our projects assignments and related learning resources with other pilots running in later times in partner sites.

10. NETPRO USER COMMUNITY

NetPro tools alone are not enough to support the actors of network based project learning. To accompany the tools, the NetPro project has built a Web based collaboration environment, the NetPro User Community, to support teachers, trainers and course designers in using efficiently the project's models, materials and tools.

The goals of the NetPro II User Community are several. First of all, the Community will serve to further disseminate NetPro models and tools, continuing the dissemination activities carried on during the project's life. It is quite obvious that an extensive cooperation among teachers and institutions would be highly beneficial, since project-based courses and course units could be shared and re-used, saving a great deal of preparation work. This concept

would become more and more practical as soon as a larger amount of materials will become available. The Community, then, will act as a broker, matching users one another with the purpose of sharing jointly developed learning resources.

Another important target is to train teachers in NBPL and to provide cases, tools, and resources to support the practical implementation of NBPL.

In NetPro User Community [6], especially the “Training” area and the “Market Place” are critical for the dissemination of the results and experiences of the NetPro II project.

The Training area includes a number of resources for teachers, educational designers and even students interested in network-based project learning. It includes the guides and handbooks developed within the project, the case studies and tools developed within the project. However, it provides also the comprehensive approach to the various resources in linking these dynamically with another. In addition, the Community provides a number of resources (such as books, articles, web sites etc.) to assist the various users.

The Market Place area is meant for exchange and dissemination of tools and resources. The fundamental idea is that within the Market Place the various originators can provide their tools and resources for the other users, while also receiving back new edited versions of the content they have been originating.

11. CONCLUSIONS

The network-based learning environment enhances project work with Internet facilities. It is useful for local work, but is particularly convenient for inter-institutional and international co-operation. The feedback from students and tutors is very encouraging [7]. The project has made provisions, through the establishment of "NetPro User Community", for the continuation, promotion and further development of its activities after the termination of the European Union's support. The long-term goal is to develop a self-funding organisation for promoting and developing project based learning on an Europe-wide scale.

REFERENCES

- [1] B. Collis, "Supporting Project-Based Collaborative Learning Via a World Wide Web Environment", in *Web-Based Instruction*, edited by B.H. Khan, Educational Technology Publications, Inc., New Jersey, pp 213 - 219 (1997).
- [2] NetPro introductory courses: <http://www.esng.dibe.unige.it/netpro/PagineLocali/esd1tlbm2003-04/index.htm>
- [3] G. Donzellini, D. Ponta, "A Learning Environment for Digital Electronics", Proc. of TAEE2004, Congreso sobre tecnologías aplicadas a la enseñanza de la electrónica, Valencia, Spain, July 14-16, 2004
- [4] A. Bagnasco, M. Chirico, D. Ponta, A. M. Scapolla, "Laboratories in Internet to improve e-learning," in Proc Eunate 2002, European Symposium on Intelligent Technologies, Hybrid Systems and their implementation on Smart Adaptive Systems, Albufeira, Algarve, Portugal, ISBN 3-89653-919-1, pp. 685-689..
- [5] Netpro advanced projects: <http://www.ing.unitn.it/~aboni/netpro/index.html>
- [6] NetPro User Community: <https://server3.hci.fi/netpro>
- [7] D. Ponta, G. Donzellini, H. Markkanen, "Electronic system design: an experiment of project-based learning on network," *European Journal of Engineering Education*, Vol. 26, No. 4, pp. 375- 390, 2001.