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ABSTRACT

The mission of the NetPro European project is to develop project-based learning through the Internet. The NetPro project is creating 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, regardless of how students are organized locally. The outcome of the project also includes practical handbooks for students, tutors, and trainers to support them in making full and effective use of the learning environment. NetPro methodologies and tools are being developed by running pilot projects: the four streams of pilots are briefly described in the paper. A formal evaluation process is an integral part of the project and its preliminary outcomes are discussed. (Author/AEF)

NetPro: methodologies and tools for Project Based Learning in Internet

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Abstract: The mission of the NetPro European project is to develop project-based learning through Internet. The NetPro project is creating 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, regardless of how studies are organised locally. The outcome of the project also includes practical handbooks for students, tutors and trainers to support them in making full and effective use of the learning environment. NetPro methodologies and tools are being developed by running pilot projects: the four streams of pilots are briefly described in the paper. A formal evaluation process is an integral part of the project and its preliminary outcomes are discussed.

Introduction: the NetPro project

NetPro is a European project that develops methodologies and tools for supporting network based project learning within the engineering curriculum. The unique approach applies principles found in collaborative (Johnson & Johnson, 1996), constructivist (Korhonen and Välimäki, 1995) and self-directed learning paradigms (Knowles, 1990). Computer networks are already used for distribution of learning materials, discussion based collaboration, submission of work, etc. However, there are no good tools available to support student-centred project-based learning activities. The NetPro project is creating Internet tools and services to facilitate communication and collaboration between distant students, and to manage access and control of project deliverables as well as electronic publishing. These tools simplify the management of project-based learning activities, saving time for staff and students. In NetPro, the project teams may naturally form cross-institutional learning communities. The outcomes of the NetPro project also include practical handbooks for students, tutors and trainers to support them in making full and effective use of this learning environment.

Project Based Learning and the net

Project based learning is a common form of collaborative pedagogy in engineering education. There are already many initiatives where advantages of new technology are being applied to support project learning (Acuna et al., 1996; Collis, 1997; etc.). In our approach the different project teams form a learning community where learning within and between international project teams is supported. This happens through sharing and peer reviewing of project deliverables, and interaction in special interest group discussions. A "deliverable" is a document submitted for assessment or review, such as an engineering design, a progress report, or a review of another group's work. The learning environment developed in the NetPro project focuses specifically on supporting project-based learning in international and multi-institutional contexts. It is based on process models with specific learning phases, and participants with precise roles. The custom Internet tools and services facilitate the communication and collaboration between distant students, as well as control of project deliverables, access to documents and electronic publishing.

For tutors the NetPro learning environment provides management tools, e.g. indexing of projects and their required deliverables and setting-up of collaborative learning activities. For learners tools are provided for distribution and sharing of project deliverables, collaborative learning activities, peer assessment and access to project and learning related information sources. Improving the efficient use of tutors' time is achieved through the Project Deliverables Centre database, part of the NetPro learning environment. It provides a structured system for allocating, monitoring and collating assessed work and for communicating with the student groups.

Inter-institutional activities

The benefits of network-based learning can be demonstrated within an institution, but they naturally lend themselves to inter-institutional working. The NetPro system has been designed to support collaboration between students from several universities. Most European universities follow similar curricula in the engineering field so in principle it is possible to have joint activities. However the philosophies and working practices of the various institutions are so diverse and ingrained that it would be futile to aim for a common structure, so the goal is to provide meaningful learning tasks for all participating students regardless of how their studies are organised locally. The first problem is working language: if the students do not share a common language then there is no point in expecting them to work together. The second problem is synchronising course content and phasing: co-operation is only possible if the classes study the same topic at the same time of year. If these two conditions are satisfied then joint working is possible. Experience has shown that cross-institutional co-operation is difficult to implement and the inevitable obstacles can only be removed by a motivated project staff.

Using an intranet to provide notes for students will usually entail some locally specific information, and this must be identified before the resource is shared. The NetPro learning environment takes full advantage of the inherently distributed nature of the world-wide web to allow local information to be embedded in a centralised system, thereby avoiding the difficulties of imposing uniformity. Even when student groups in different institutions are working on the same project, each group can be assessed according to local practice.

The Network Based Learning Environment

The NetPro learning environment is a distributed system where each participating pilot site has its own local learning environments integrated to the collaboration space provided by the project. The collaboration space is a database application with user specific Web interfaces which facilitates sharing and peer reviewing of project deliverables, and interaction in special interest group discussions. The application is used through a standard Web browser. Users do not need any knowledge of Web authoring or special tools to use the application.

Project Deliverables Centre

The Project Deliverables Centre (PDC) is the core of the NetPro learning environment. It has two primary purposes: to support knowledge sharing between students, and to ease the tutor's workload in high level project management. Students deliver their work for assessment or review by depositing it in a file and uploading the file

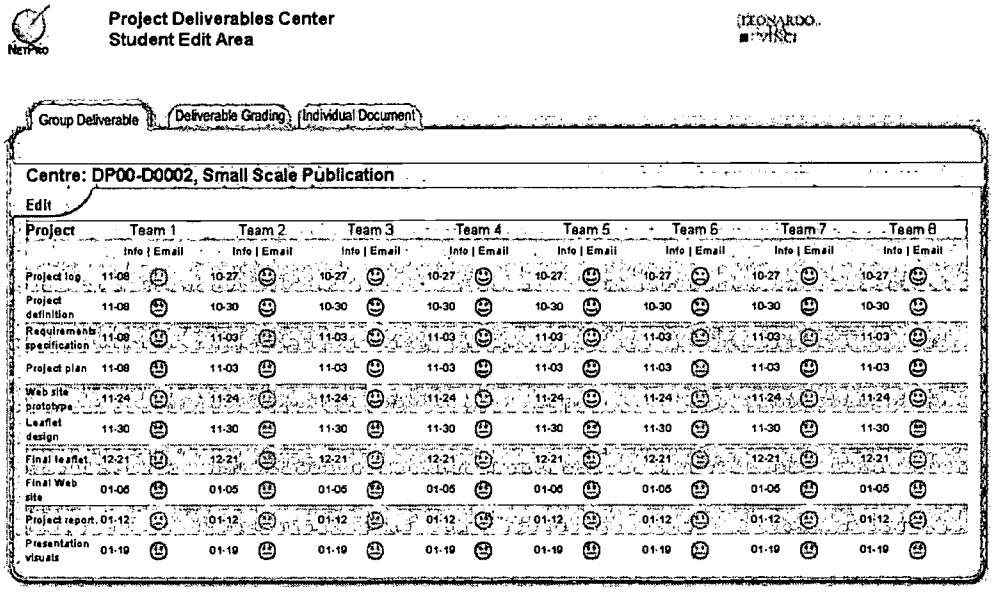

Fig. 1: Student view of a Project Deliverable Centre

to a Web server using a custom GUI. The main view of the PDC is a graphic which shows which items have been delivered, using a coloured-smiley metaphor (Fig.1).

Features of PDC

The Administrator view of the PDC helps the supervisor to modify data within different projects:

- create, modify and delete PDCs
- create, edit and delete student groups for a PDC
- define deliverables for a PDC
- assign groups for peer reviews
- view peer assessment results

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. This student can then update their own group's data:

- view PDC
- edit group details
- deliver work for assessment or peer review
- access other groups' work for reviewing
- assess group members' contributions to the joint effort (peer assessment)

Peer review

Reviewing other groups' work can enhance the learning experience of project students, for both the reviewer and the reviewee. Different groups can design parts of the system using different approaches. After the designs have been completed and documented the groups can do peer reviews about these different approaches and see their benefits and drawbacks, so the all the groups can learn from each others' work.

The PDC allows the tutor to allocate cross-group review tasks, and it displays their status so that each group knows when their reviewee's work is available for review and when their own work has been reviewed. These peer reviews form part of the assessment requirement and are, like all deliverables, delivered by entering their URL into the appropriate field in the GUI. 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.

Peer Assessment

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. Each student can see whether their colleagues have completed this task, but the values awarded are concealed until everyone has done it. It is of course up to the supervisor to decide how to use these data.

Discussion spaces

The problem of communication among the actors of the learning process is a general issue and goes beyond the boundaries of the Netpro project. A successful exchange of information among students is, of course, very beneficial for learning, but it is not possible to force them to talk to one another constructively. With inter-institutional working, the problem is made worse by the impossibility of using face to face communication that must be replaced by some other tool. In NetPro, each project has available one or more open discussion spaces, called Special Interest Groups (SIGs). They are a 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.

The Handbook

NetPro tools are, of course, very helpful to anyone developing network-based project learning. Tools alone, though, are not enough: adequate documentation and help must support the actors of the NBPL process to understand the methodologies and put them into practice. To complement the tools we are preparing a handbook which provides a step-by-step guide through the process, and each step of the process includes a planning/implementation tool. The handbook will include:

- checklists (e.g. process checklists or checklists on copyright etc.)
- templates (e.g. Word documents for course planning)
- case studies of good practices
- curriculum models
- guidelines/models for learning project manuals
- design guidelines for course web sites ("House Style")

The handbook includes extensive case studies that synthesise the experience made by the project partners in the pilot courses.

Pilot courses

The goal of the pilot courses is to test and evaluate the network based project learning methodologies, environment and tools developed in the NetPro project. The pilots' learning environment consist usually of a problem specification and assessment requirements that may be supported with related network based learning material and documentation. Traditional lectures, tutorials and laboratories integrate the NBLE. The students study the provided material and do what the problem requires. The tasks require subject-specific engineering knowledge and project-management skills to be applied. This work of students is defined as the student project, and it forms the context in which the NetPro team is developing the NBLE. The pilot courses are implemented in the real study context of students, i.e. they are fully integrated into the curriculum of their study programme and the students earn credit units by carrying them out.
Because curricula at the partner universities differ considerably and the project makes no attempt to harmonise them, common areas of subject matters in information technology have been identified and the pilot courses have been designed around them. Each pilot site is be 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.
During the life of the project, four streams of pilot courses have been running and evaluated by the project partners:

- Interactive Web Application (http://pww.evitech.fi/nble/studies/courses/)
- Multimedia Authoring and Applications (http://pww.evitech.fi/nble/studies/programs/e4098/courses)
- Weather Station (http://pww.evitech.fi/netpro/pilots/ws/)
- Electronic System Design (http://www.esng.dibe.unige.it/netpro)

Within each stream, several individual pilot courses have been designed and carried out, in two separate runs of piloting activities. Because of the preliminary nature of the work and the institutional constraints, not all the pilots provide a full implementation of all NetPro features. Instead, each pilot usually stresses one or more aspect of the pedagogical scenario involved.

The goal for the students' projects in the **Interactive Web Application** pilot course is to design and develop an interactive information service application on the Web. The project integrates the knowledge and develops students' practical skills e.g. in application development methodologies, visual design, programming, project management and teamwork. Students' projects are organised as an application development process that covers the phases from an idea to a product. Students practice the use of basic methods and tools needed in project definition and planning, requirements definition, application design, and implementation.

The learning projects in **Multimedia Authoring and Applications** produce a multimedia product or service. The exact topic of the project was left open for each pilot site to define as the related course objectives and arrangements differ. The common subject matter was the design and production process of multimedia applications including: information content, interactivity, visual design, methodologies and tools used in production.

The objective of the **Weather Station** pilot is to establish and gain experience of a NBLE in the fields of physics, electronics and software engineering. The design of a weather station is used first for demonstrating the development of a simple electronic system in which physics, electronics and programming knowledge and skills are essential. The first implementations of the Weather Station pilot have focused into analogue electronic design.

Electronic System Design (ESD) stream of pilots has produced a learning environment for digital electronic design, investigating especially the applicability of the NBLE approach in the context of introductory courses (Donzellini, Markkanen and Ponta, 2000). It has also verified the functionality of the NetPro tools for managing large numbers of project teams, as well as the possibility of implementing new formats for inter-institutional co-operation.

Course-specific learning environments

In addition to the general purpose project management structure, a NetPro course may need a specialised environment supporting the student in the project development. It may consist of technical and pedagogical resources, such as multimedia trainers and simulators.
We developed a learning environment for digital electronic design for the ESD stream of pilots, in view of their particular nature of introductory courses. They target a student population non-homogeneous in terms of background and motivation and, therefore, they cannot replace completely traditional lectures with project-based activities.

The core of the learning environment for digital electronics is represented by simulators specifically designed for educational applications. They are extremely useful to students in many phases of project development, from producing drawings of digital networks and timing waveforms to checking the behaviour of the blocks designed for the project. Their pedagogical orientation avoids the unnecessary cognitive overhead that the students should take for learning how to use professional simulation tools.

Feedback from students and teachers

A comprehensive evaluation of the NetPro project has been carried out by a partner institution, Scienter of Bologna, Italy. It covers not only the experiences of students and tutors at the operational end of the scheme but also the management of the NetPro project itself. The following are extracts and elaborations from the evaluation reports.

Students' view

Students' data and opinions related to various aspects of the course have been collected by means of an anonymous questionnaire. The evaluation report is based on the analysis of 350 returned documents.
Below we show a brief synthesis of the opinions expressed by the learners about project-based learning:

- In general, students accepted to change their usual learning methodology.
- Learners appreciated to have more responsibility, more freedom and to work in a group.
- Although students show a high level of autonomy and maturity in carrying out their work, they still need some control and some guidance.
- Most found project-based learning closer to real-life cases and said that it makes learning much easier and more motivating.

The following views refer specifically to network-based project learning:

- Students would like to attend again a course involving network based project learning/project work. A few asked for some changes.
- Peer reviews were considered a good idea in principle, but many expressed concerns on their practical implementation.
- The interaction among students was, on the average, judged only marginal. Many complained about the scarce attitude toward communication of their peers and the overhead represented by the use of the SIG tools.

Of special interest is the synthesis of 99 questionnaires of the Electronic Systems Design 2 pilot (ESD2), because all the teams had the experience of the previous pilot course ESD1. The questionnaire was designed in a way to investigate the confirmation or denial of prior outcomes.
In fact, students confirmed many positive judgements expressed in the ESD1 evaluation. They, again, found NetPro useful, interesting and stimulating. They also appreciated more than before the possibility of working in teams, to learn to manage their own time and to develop material for the net.
A problem common to all pilots has been the reluctance of students in using SIGs. Many students found them time-consuming, awkward to use for the necessity of typing and using a foreign language, not able to provide timely information. In ESD2 we tried to encourage the communication on SIGs by assigning problems that required an intense exchange of information to define their final specifications. A comparison between the two project sites shows a vast increase of communication and an improvement on its quality.

Teachers' view

Teachers agree with students that project learning increases motivation of both actors of the learning process. They see NetPro approach as a very valuable one not only for project-based subjects, but also for those taught by traditional classroom-lecturing, where the project can form part of practical sessions and can be integrated into the curriculum. The main points highlighted by teachers concerning network based project learning were:

- NetPro tools facilitate management and supervision of projects
- Learning of personal skills is emphasised
- The sharing of knowledge is encouraged.
- The focus of the learning is on working processes, in addition to the factual content.
- Learners become the centre of the process, instead of tutors.
- Project work provides learning experiences that are similar to working life situations.
- The networked environment extends the boundaries of the learning community.

Key success factors identified by teachers were the following ones:

- The change in the tutor's role should be supported by the organisations.

- Networked learning activity support learning well but they needs to be carefully planned (integrated in the local curriculum, explained to the students).
- Project teams' failure to meet deadlines causes heavy problems for the networked learning activities.
- Students need to be motivated and to clearly understand the benefits of project work.
- The use of peer reviews was seen (but not by everybody) as entertaining and exciting, but this approach should be introduced in the first phase of the project so that groups can have real communication.

NetPro2: the continuation

The project resulted in novel pedagogical approaches and an original set of network based tools that support project based learning (PBL). The large-scale evaluation of these tools proved their effectiveness. However, during the validation of the pedagogical models and tools, the need to extend the existing approaches and to develop new ones has been identified. Therefore, a new proposal for 2001-2003 has been submitted to the European Union, in order to continue the activity, under the name of "NetPro 2".

The novel pedagogical models to be developed will respond to the need for closer integration of vocational training to working life. It will be solved by applying models of network based collaboration used in modern work organisations. The learning models and network tools will also be piloted in further vocational education courses where students are working by combining their work projects as part of their curriculum.

Current stable technologies accessible to educational institutions do not support effectively innovative pedagogical approaches based on models of collaboration used in modern working life (i.e. work of geographically distributed teams). The intensive interaction required by such teamwork has so far not been possible without expensive investments in special technologies. The technology is finally approaching the stage where many threshold-type of products and services, such as Internet based audio and video communications, data format for structured document interchange (XML), meta-data standards for educational purposes (ARIADNE, IEEE/LOM), will be available for larger user communities.

NetPro 2 will take advantage of these emerging standards to develop more realistic collaborative pedagogical models. The partnership will focus on the transferability of the tools as the emerging standards make this feasible. The project will also start the preparation for the large scale transfer activity by prototyping the concept of "NetPro Learning Communities". The long-term goal is to develop a self-funding organisation for promoting and developing project based learning on an Europe-wide scale.

Conclusions

A successful network-based learning environment for project work has been developed. It is useful for local work, but is particularly convenient for inter-institutional working including international co-operation. It has been used on several pilot projects, and development is continuing in a new project. The feedback of students and tutors is generally favourable. In addition, a "handbook" for tutors (in on-line form) has been prepared.

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