

# Collaborative Network Space: Infrastructure and Learning Application

M. Anton, M. Vall-Ilosera, J. Torres, J. Romeu, L. Jofre, F. Solé, F. Marqués, F. Sabaté, J. Berenguer,

**Abstract** — Collaborative learning is attracting increase attention as a methodology to simultaneously improve motivation and interactivity. In order to fully enhance its potentialities appropriate technological platforms and academic experimentation are needed. In this paper a master course level experiment is presented based on the learning infrastructure defined.

**Keywords** — Knowledge Server, Learning Space, peer-to-peer, collaborative learning, engineering design.

## I. INTRODUCTION

Nowadays the trend in computing is undeniably decentralized. In this way, it is visualized the presented Learning Infrastructure in a distributed net where different peers create, share and improve knowledge following the constructivism theory [1] that claims that knowledge is actively constructed by the student (peer), not passively absorbed from textbooks and lectures. This “open knowledge” is public, distributed and is in every PC.

Once the learning environment has been defined, in order to see how it can improve the creation of knowledge, it has been applied to a real experience, conducted with telecommunication engineering students of the Technical University of Catalonia (UPC).

In the following sections the definition of the Learning Space is given and later on it is explained its application to Higher Education and its results.

## II. NET LEARNING INFRASTRUCTURE

Considerable work has been done in the area of E-Learning. The increasing demand of these environments has caused the appearance of Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) that easily build systems to manage learning activities over the net.

An infrastructure where the most important idea is the concept of “Learning Space” is proposed. Every peer in the net has a personal space that allows him to learn or share their own knowledge with other peers. Each peer is a net node consumer and producer of knowledge and his PC is the key to do that.

Two concepts are essentials in this infrastructure:

- *Learning Space* (LS): tools and services that a personal space requires to create, manage and share knowledge in the net. It has to achieve the following functionalities:

exchange information (documents), exchange knowledge (structured information), a synchronized communication between peers, an advertisements panel, a forum and a system log.

- *Guest Learning Space* (GLS): space in the net that allows any user that can't have a personal LS to join the learning community. It is a shared public space, full time available, with a reduced version of the LS functionalities.

The LS and the GLS had to be offered by real implementations that achieve their purposes. It is here where the Knowledge Server and the Guest Server appears. Former it is explained the Knowledge Server that will offer a LS and why a Super-Peer is needed to accommodate the Guest Server.

### A. Knowledge Server

The Knowledge Server (KS) is defined as a PC with specific client-server software that allows us to interact with other KSs through P2P paradigm and that implements the LS functionalities.

It is composed of different units that work together to materialize the LS. Some of them are “open-source” oriented other have been implemented with Java. The different units must be transparent for the user so a graphical interface has been developed to make easier the interaction.

Figure 1 shows the final architecture of the KS.

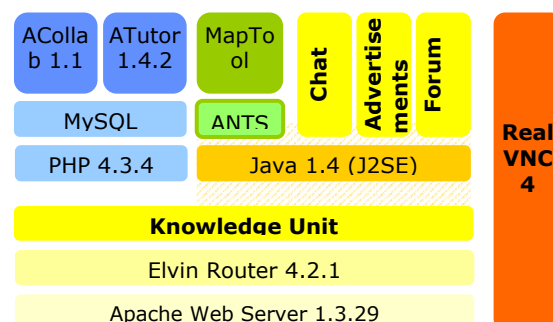


Figure 1: Knowledge Server (peer) architecture

ACollab, Atutor and Maptool are off-the-shelf freeware software and for their correct work it is needed a web server (Apache with PHP enabled), a publish-subscribe messaging server (Elvin Router), a data base (MySQL) and the Java Runtime Environment.

In addition, it has been developed an application in Java that overcomes the rest of functionalities, which is known as Knowledge Unit and deals with:

- synchronized communication with a simple chat
- advertisements panel
- forum
- creation of a unique space that permit an easy management and access to other units
- communication P2P between different KSs

In the Knowledge Server architecture also appears a unit called Real VNC [2]. It is a remote control software which allows to view and interact with one computer (the "server") using a simple program (the "viewer") on another computer anywhere on the Internet. The viewer can be a simple browser so it is not necessary to install any extra software. This unit is added to the KS because the LS is understood as a personal space that can be managed and accessed from anywhere in the net and with any of the present technologies (WAN, Wi-Fi, 3G, etc.).

### B. Super-Peer and P2P environment

One of the most important aims in this project is to build a P2P learning infrastructure. Node equality in P2P nets has a dramatic impact on the way systems are architected and built. The question is how to search for peers and from the learning community if there is not any hierarchical structure. A clue to solve this problem can be found in early systems like Napster, Gnutella and Freenet. Nevertheless, any standard way to do it is defined.

In this infrastructure it is essential to find connected peers so they can share knowledge. An effective discovery mechanism is critical to the successful design and deployment of the peer-based network. There are a number of decentralized discovery methods that use a variety of designs and architectures based on simple, selective or adaptive broadcast.

JXTA [3], an open network computing platform designed for peer-to-peer computing, is reliable enough in finding peers and sending messages over the net to ensure the right work that we desire for the P2P learning community.

To summarize all decentralized methods have tradeoffs or are difficult to implement. For this reason, it has been chosen a hybrid model that breaks the rule of equality of nodes. It has been added to the infrastructure, as shown in Fig. 2, a centralized peer discovery node but the knowledge exchange resembles a point-to-point network. This function is called Discovery Server (DS) and the node that accommodates it, Super-Peer.

As the figure shows, in the Net Learning Infrastructure there is a node (peer) with different functionalities which has to be on-line 7x24 with the risk of single point of failure that it is assumed at this moment.

To make the most of having a Super-Peer in the infrastructure, the Guest Server (GS) is installed in it. GS implements the Guest Learning Space which has to be always accessible. The presence of Super-Peer is seen as the need of a node that accommodates the DS and the GS.

DS is implemented with PHP scripts that access to a data base while GS is implemented with HTML and PHP and also includes a little Java server that responds to

queries from peers in the Virtual Learning Community (VLC). ATutor and ACollab are included in the Super-Peer to offer a space to leave knowledge (courses) or documents making them accessible to other peers presents in the VLC.

### C. Overall vision

Fig. 2 gives the overall vision of the Net Learning Infrastructure with all elements. Particular attention is given to the VLC that is composed of on-line KSs (peers) and guest users that access through GS. They can share and discuss their own knowledge in a P2P way.

The image of a KSs off-line represents that they do not participate in the VLC in this moment. Finally, it is interesting to highlight that the remote admin of KS can be done from another PC with a simple browser and also from a PDA with a little Real VNC client.

## III. THE CLEAR PROJECT

In order to gain experience and to obtain practical guidelines, we have designed a real cooperative learning experience based on an engineering master course, called CLEAR, Collaborative Learning on ECTS Array Resolution. This name refers to a set of actions that has been conducted in order to create the interactive learning module "Array Antennas", equivalent to one ECTS (European Credit Transfer System). This unit is part of the compulsory subject of Antennas in the fourth course of Telecommunication Engineering in the UPC.

The main aims of the experience have been testing how the infrastructure shown can foster the progressive work of the students and their innovative and creative spirit while making them able to relate more easily theoretical concepts with real structures.

The experience has been defined so that learners are able to get deeper and assimilate better the key concepts and to develop additional innovative skills.

The trial has been focused especially from the pedagogical point of view on promoting teamwork, decision making and writing capabilities and from the technical side on assessing how the learning infrastructure presented can help students to achieve these abilities. In addition we are mainly dealing with the research questions:

- To what extent can the Net Learning Infrastructure improve the learning outcomes?
- To what extent students are satisfied with the Group-based Learning experience and how they feel about acquiring skills that may benefit them in the near future?

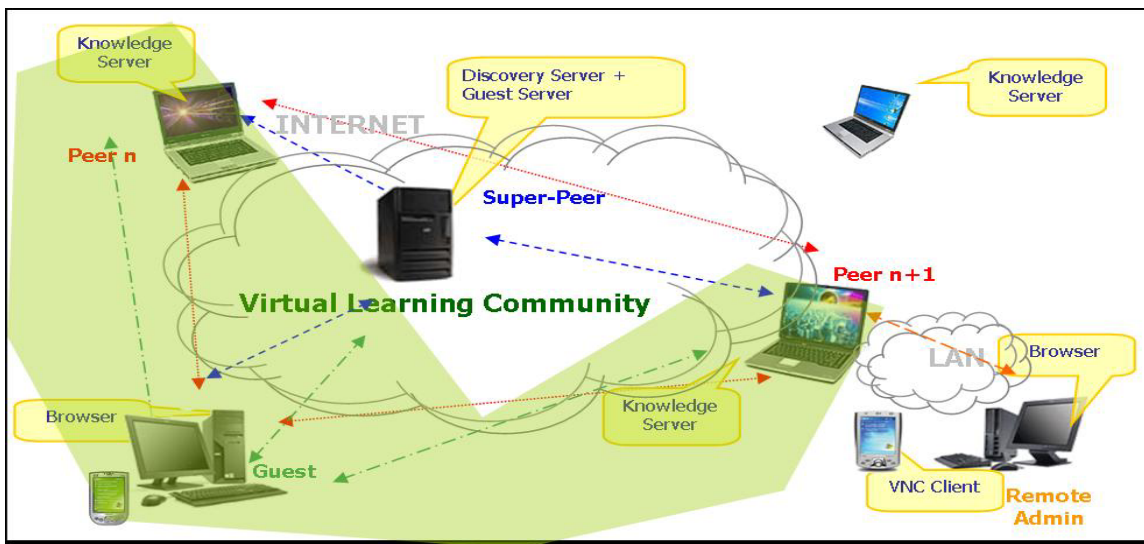


Figure 2: Net Learning Infrastructure

### A. The Collaborative Learning Trial Process

The process has been conducted the both of the semesters of the course 2004-2005. As a pilot, the trial has been experienced with 15% of the students attending the subject (41 of 282 during the first semester and 29 out of 239 during the second), who have freely elected the choice of assessment, between traditional methodology and collaborative work. In this way the participants have had interest in the project to be done, being this an optimizing factor in the process.

This collective has been organized in 14 and 10 groups respectively, composed of 3 students each. To promote socializing aspects people in a group have been mixed from each one of the class groups intending to have components who may meet for the first time. In this way they need to develop trust so as to work efficiently. The Learning Space has been used to overcome non-matching schedules within a group.

Related to the high number of groups we can find the need of a supervisor who manages the information and the learners doubts. This figure supervises the behaviour of each group to make sure it works effectively and else tries to improve their performance [4]. The supervisor allows the faculty to reduce the time load involved in such a methodology change.

#### The main task

Students have been assigned to do a design of an antenna array as the main task of the cooperative work. A simulation tool, ADAS, has been given to them as a design tool.

Choosing a design is because it allows the learners to deal with an Open Ended Group Project (OEGP) [5] and so they have the challenge of solving a real problem, they may tackle in their professional life, as team. Engineering design implies some tradeoffs such as quality and cost relation. Therefore decision making efforts have to be done whereas learners feel more motivated as they play an active role in the process. They need to weigh up the consequences of their choices as a whole and as a result they may need to critically analyze the possible solutions.

To fulfil the design requirements the project has been proposed divided in four tasks. Students can distribute the

work between them or work as a whole in every part. In any case the comprehension of every section is needed to advance. So every member may work on a part but transmitting and sharing their knowledge in a constructivist way. Lastly, students have been assessed by a final report, where results and explanations about the process have been asked for. So it promotes writing skills and synthesis capability, as they have to express by their own the reasons of every step taken during the design.

#### The cyber-icebreaking phase

As pointed out by Tolmie [6] one of factors involved with successful Computer Mediated Communication (CMC) use in Higher Education is the knowledge of the other components of a group. Although it is very important, actually it does not happen this way. So developing trust within the group becomes a key factor and an icebreaking introductory phase is useful in these projects. Some trials carried out in this area show that though higher complexity in this stage can make it more attractive to the participants, they consider simplicity very important as well [7].

Another key factor taken into account is the ownership of the task; in this regard it is better if students have the chance to negotiate what task is to involve [6].

Considering these elements the icebreaking phase has been defined as follows: first of all each participant has introduced some handy personal information and a picture so as to let others know him/her. Then they have altogether discussed how to distribute the tasks and have had to agree on a common schedule in their virtual workspace.

Defining this phase in this way gives the students a shared goal, so it has sense to do it, it means a first decision making action and a first approach to the technology.

#### B. The Software

The learning infrastructure helps students to work together overcoming scheduling problems and it becomes the basis for managing the information, the groups and a way of surveillance of their improvements.

The learning environment has to facilitate:

- Communication within the group.

- Documents sharing.
- Information of the use of the tool by each member.
- Ease of access everywhere on the net.
- Learning approach.

Due to conducting this experience for the first time the most valuable things while sorting out the software have been security and reliability. If any problem had appeared in the use of technology, it wouldn't have been possible to work out the performance of the students. With this purpose, some of the more suitable options for the trial have been tested to check out these features.

Finally it has been decided to use BSCW (Basic Support for Cooperative Work) [8] in the top the Learning Space infrastructure. This system has an extensive background, it fulfils the requirements asked above, and you can go through easily and intuitively, which is important as far as both students and teachers were going to be exposed to such a high number of changes. Technology was necessarily undemanding, to make things easier, becoming another collaborative agent.

Within the main advantages of the tool we can find:

- File sharing is independent of the computer.
- It is not necessary to install any software. Only a web browser is needed.
- Only to own an e-mail account is asked to register.
- BSCW sends daily reports of any action occurred in the workspaces you may be member.
- A user can be characterized what by his/her role, defined by the administrator, and profile, which goes from Beginner to Expert through Advanced.

This groupware stands both synchronous and asynchronous communication. For the last one it is based on the concept of workspaces, where groups can store, manage, edit and share files. Regarding the synchronous way it gives the chance to work with different tools for instant messaging and communications accessories, that offers for instance web cam and digital whiteboard.

### C. Results

#### *Students' performance*

The quantitative evaluation of the trial shows that the change has been positive to the students.

The 15% of the students has been partially assessed by the cooperative design whereas the other 85% by an ordinary exam. Even so both of them have had the same final exam. So a comparison of their final exam results can show which have been the effects in their learning outcomes. The overall assessment of the experience is based on the final examination score and grades in the specific problem of arrays obtained by the two groups.

62% of the whole of students have passed the subject and raises to 73.8% in the trial's students. A final exam's grade higher than 7 out 10 has been achieved by 18.75% and 19.35% respectively.

TABLE 1: GRADE ON THE ARRAY EXERCISE FROM 0 TO 10.

Group with final grade > 7	7.95
Trial participants	6.96
Whole group passing the subject	6.51

### *Qualitative evaluation*

Students were asked to answer a questionnaire containing open-ended questions about both the activity and technology. It has freely given back by 73.8% of the participants. But most of the groups expressed their satisfaction adding their opinions in their final report.

They agree that the experience will be useful for their career and that it is more motivating than traditional assessment. On the other hand, in their opinion it needs a higher inversion of time. Even so they feel satisfied with the chance taken. And they think they have learned more deeply the theoretical notions involved and the ability to work in team with simulation tools. Finally some of them have proposed to add an oral presentation to develop oral skills as well.

## IV. CONCLUSION

To conclude the use of distributed networks are becoming more important in computing fields, in particular the hybrid model chosen in this project appears to be an improved solution in learning environments.

The trial has taught that in spite the effort that teachers have to make, this kind of activity lets achieve the desired goals and at the same time has as a result a high level of commitment. Students get involved with the matter they are learning, with the way they are doing it and with the other components of the team.

So results encourage to conduct it again in further semesters, increasing the number of participants. With this purpose it has been developed a tool to electronically manage the assessment of the students.

## REFERENCES

- [1] M. Ben-Ari, "Constructivism in computer science education", ACM SIGCSE Bulletin, vol. 30, no.1, pp. 257-261, 1998.
- [2] T. Richardson, Q. Stafford-Fraser, K. R. Wood and A. Hopper, "Virtual Network Computing", IEEE Internet Computing, vol. 2, no.1, pp. 33-38, 1998.
- [3] JXTA Technology: Creating Connected Communities (2004). [Online]. Available: <http://www.jxta.org/docs/JXTA-Exec-Brief.pdf>
- [4] T. Clear, "A diagnostic technique for addressing group performance in capstone projects", ACM SIGCSE Bulletin, vol. 34, no. 3, pp. 196, 2002.
- [5] M. Daniels, X. Faulkner and I. Newman, "Open Ended Group Projects, Motivating Students and Preparing them for the 'Real World'", IEEE Conference on Software Engineering Education and Training, Covington, USA, 2002.
- [6] A. Tolmie and J. Boyle, "Factors influencing the success of computer mediated communications environments in university teaching: a review and case of study", Computers and Education, vol. 34, pp. 119-140, 2000.
- [7] T. Clear and M. Daniels, "2D and 3D introductory processes in virtual groups", ASEE/IEEE Frontiers in Education Conference, Boulder, Colorado, 2003.
- [8] BSCW Homepage: <http://bscw.fit.fraunhofer.de>