Please cite the source as:

Cenich, G. & Santos, G. (2005). A learning proposal based on a project and collaborative work: An online course experience. *Revista Electrónica de Investigación Educativa, 7* (2). Retrieved month day, year, from: http://redie.ens.uabc.mx/vol7no2/contents-cenich.html

ISSN: 1607-4041

Revista Electrónica de Investigación Educativa

Vol. 7, No. 2, 2005

A Learning Proposal Based on a Project and Collaborative Work: An Online Course Experience

Propuesta de aprendizaje basado en proyecto y trabajo colaborativo: experiencia de un curso en línea

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(Received: November 30, 2004; accepted for publishing: June 13, 2005)

Abstract

One of the basic necessities for education in the future is to prepare learners to participate in a computer network, since in the information society knowledge is the most critical resource for social and economic development. This paper addresses how project-based learning was designed and implemented in a course on computer science at the National University of Central Argentina. The objective of the course was to engage students in the production of projects that were authentic, meaningful, and intended for future teaching and professional use. Two types of interaction have been considered in computer-mediated learning: individual interaction (interaction with the content), and social or interpersonal interaction. This paper describes the course design, provides an overview of the processes involved in developing the project-based learning activities, and reports the responses of students to the course.

Key words: Training, virtual education, project-based learning, collaborative learning, activity theory.

Resumen

Una de las necesidades básicas de la educación en el futuro es preparar a los alumnos para participar en una red de computadoras, dado que en la sociedad de la información el conocimiento será el recurso más crítico para el desarrollo social y económico. Este artículo trata acerca de cómo se diseñó e implementó el aprendizaje basado en proyecto en un curso de grado de enseñanza de informática en la Universidad Nacional del Centro de Argentina. El objetivo del curso fue comprometer a los estudiantes en la producción de proyectos que auténticos, significativos y pensados para la enseñanza futura y el uso profesional. Se ha considerado la interacción en el aprendizaje mediado por computadora como de dos tipos, interacción individual (interacción con el contenido) e interacción social o interpersonal. Este artículo describe el diseño del curso, proporciona una vista general de los procesos involucrados en el desarrollo de actividades en el aprendizaje basado en proyecto y da cuenta de las respuestas de los estudiantes en el curso.

Palabras clave: Capacitación, educación virtual, aprendizaje orientado a proyecto, aprendizaje colaborativo, teoría de la actividad.

Introduction

This paper describes the experience of project-based learning and collaborative work done in the Chair of User-Oriented Informatics, in the Informatics Education degree program of Exact Sciences, National University of Central Buenos Aires, in the Province of Buenos Aires. This department aims to prepare future teachers in the specific field of business training in virtual environments. A design is proposed for a learning environment that attempts to engage students, future professionals of formal and informal education, in the development and implementation of a meaningful and authentic training project in an organization.

Modern organizations require new training methods that involve the development of skills for problem-solving, decision-making, the ability for collaborative work and flexible adaptation to the rapid changes produced in the information society.

These needs present a challenge to prepare professionals in this new world of educational problems. The core objective of this subject is to enable students to internalize, on the one hand, the specific aspects of the business skills, and on the other, the potentials of using information technologies (ICT) and communication in virtual education.

In particular, there are detailed the teaching strategies, the learning activities and the final projects submitted by students. Furthermore, analyzed are the responses of students to assess the degree of effectiveness achieved in learning supported in the development of projects.

Theoretical framework

Most teachers have been trained in traditional education in traditional settings, in which the most meaningful practice of education is the concentration on teaching the theory (Schank, Berman, and Macpherson, 2000), under the assumption that knowledge can and should be transmitted from teacher to student. From this perspective, the expected outcome is for students to replicate the content and structure of the world in their thinking, and the role of education is to help students learn about the real world. In this context three problems can be distinguished:

- Teaching focuses on knowing *what* and not on *how*.
- The new knowledge does not help students to achieve a goal that is meaningful and useful to them.
- Students learn in a decontextualized manner.

Contrary to these notions of knowledge and learning, constructivism regards learning as an internal process of understanding, formed when the student participates actively in understanding and knowledge production (Mayer, 2000). Social constructivism (Vygotsky, 1978/2000), argues that culture and context are important in the formation of understanding. In this paradigm, learning is not a purely internal process, but is a social construct mediated by language used in social discourse, where the context in which it occurs is the center of learning itself. The nature of knowledge and the knowledge-construction process originate in the social interaction of people who share, compare and discuss ideas. It is through this highly interactive process that the student constructs his or her own knowledge.

In other words, knowledge is considered to be embedded in and linked to the situation in which learning occurs (Applefield, Huber and Moallem, 2001) as an active process, determined by complex interactions between students' existing knowledge, social context and the problem to be solved (Tam, 2000).

From the above, two main characteristics can be highlighted in the learning process: problem solving and collaborative work. For the first, there are required *good problems*, significant and truly complex, to stimulate the exploration and reflection necessary for the construction of knowledge. The second feature relates to interaction with others, working together as peers, applying their combined knowledge to solve the problem (Tam, 2000). In this way, students engage in an ongoing collaborative process of building knowledge in an environment that reflects the context in which the knowledge itself will be created *in situ* (Hamada and Scott, 2000).

In this framework, learning occurs only in the meaningful context of the activity, and therefore it is important to analyze the activity and context as part of the instructional design process. The link between an activity and the community that carries it out could be represented by the sociocultural lens offered by the Theory of Activity (Leont'ev, 1978). This considers the activity system as the primary unit of analysis; it allows the study to be centered on activities that a group develops, the instruments they use, the relationships established, and the objectives and intentions that guide the activities and results thereof. It especially emphasizes the interaction between human activity and consciousness, within a relevant context, where these not only coexist, but support each other. There is a reciprocal regulatory feedback between knowledge and activity. When we act, we gain knowledge, which affects our actions, which in turn, change our knowledge, and so on. That transformation is the central point of the learning concept of the activity theory (Jonassen and Rohrer-Murphy, 1999).

The new dimension which distance education has acquired from facilities, benefits and opportunities offered by ICTS for the distribution of information and communication, has motivated new approaches to the teaching-learning process. The main factors involved in web-distributed learning are: the structure of the course, be it be sequential, hierarchical or elaborative (Grabinger and Dunlap, 1996); the learning activities (Jonassen, 1997); the didactic materials offered; patterns and strategies of communication (Peal and Wilson, 2001); the evaluation (Olea and Ponsoda, 1998) and the role of tutor/teacher and/or moderator (Salmon, 2004). This new modality requires, as well, new teaching strategies, focusing on the design of instructional materials (Berge, Collins, and Dougherty, 2000).

Learning is mediated by activities designed to improve student understanding and the meaning of knowledge, through interaction with the same material at different times, in contexts reconfigured for different purposes and peer interaction for the sharing of knowledge (Jonassen, and Rohrer-Murphy, 1999), generating the reflection and active engagement of students (Moallem, 2003). It should be noted that the space created by the separation between student and teacher is a transactional distance, which can lead to a potential loss of comprehension (Moore, 1990). Therefore, special attention should be paid to the two dimensions which characterize the transactional distance: *dialogue and structure,* and thus attempt to carry out the teaching-learning process effectively.

Specifications for the design and implementation of the course

The course was designed to be carried out in a distance learning modality via the Internet. It was aimed at the students of a degree course in computer education—learners who have a diploma for not less than three years in the discipline at university level.

The course hoped to develop in students, knowledge on training, distance learning, course design and implementation of courses on a web page editor, allowing them to develop an integrated project in response to a real training problem. It was also expected to promote in students a reflective attitude regarding their performance, in a virtual learning environment with strategies and skills they had to acquire or develop for success in the new environment, and which had to be taken into account when producing solutions as trainers. For this, students were assisted by a mentor who served as counselor, advisor, guide, motivator, and problematizer of approaches related to the teaching content.

The implementation of the course was conducted using a web page with general and specific information about the course. This page had links, always available, which provided access to:

- The objectives. Outline the problems to be explored and gone into in greater depth through the development of material, and define the educational goals an effort would be made to meet.
- Contents. Presented by module, including activities; they were available for download, and include references.
- Communications tools. We offered the various instruments which would be used for communication between the tutor and the students, and between peers in the course. There was a board of novelties, which had updated information on the tasks to do, with the dates suggested for beginning and completing them. E-mail was used as a permanent means of communication with the tutor. Through it, students received activities and the guidance needed to carry them out.

Some activities required for their implementation a space for discussion and sharing of the different opinions of the group members. For this, a Yahoo *group* was created. This also offered a forum tool, plus the ability to exchange information through files and to conduct surveys. The personal e-mail mailboxes were used for communication with the tutor and with peers.

Proposal and teaching strategies

The teaching proposal had as its primary axis the promotion of learning development through the production of projects answering to a real and significant training problem. Its objectives were: a) to promote in students the connection between knowledge and the contexts of the application, and at the same time, b)

promote reflection on the processes developed in preparing the solution, emphasizing the creative and intelligent use of ICTS.

The problematic situation to be solved through a project was expressed in an incomplete manner, as a contextualized problem, poorly structured, with multiple solutions (Jonassen, 1997); i.e. the problem statement did not contain all the information needed to solve it. Getting possible responses from the students required putting into play the knowledge and skills developed throughout the course. Possible solutions were not restricted to the mastery of contents that had been studied and were not predictable or convergent. Students were expected to specify the limits to the problem through assumptions and judgments which expressed personal opinions and were based on the subject contents. This facilitated discussions among the students to identify the main features of the problem that motivated them to explore the mastery of the knowledge required.

To introduce students to the knowledge needed to interpret and understand the problems of training, distance education and implementation of training courses, we proposed an additional teaching strategy which operated parallel and complementarily to learning based on projects: *scaffolding activities* (Collins, 1997). The use of these tasks had two purposes: impel the student to 1) interact with the mastery of knowledge needed to interpret and carry out the project, and 2) become familiar with the new working environment and develop or acquire skills to function properly in a virtual environment.

During periods in which the student had interact independently with the material, she* was guided by the tutor through the exchange of emails. The tutor responded to the concerns, doubts and questions raised during the learning process and clarified or reinforced concepts, as well as proposing new materials (bibliographic and electronic links) to extend and clarify the mastery of the concept under study.

To address the issue of corporate training, a set of activities was proposed to the students, for the purpose of exploring and internalizing the concept mastery required for the analysis and identification of the real needs of a business.

An estimated time was given for students to solve individually the proposed activities, working with the material provided by the department head and assisted by the tutor.

In a second stage, the tutor assigned various activities to each student, and learners had to add to the Internet work group the files of the assigned activities, together with their solutions. It was suggested to each student that he read the various proposals of his peers, compare them with his own answers; he could,

* Translator's note: Before the feminist movement arose, in situations including both genders it was customary to use the masculine pronoun. Today, however, pronouns of both genders are used to avoid what is now seen as sexist language. To avoid the awkwardness of continually using "s/he", "his/her", we shall, in this paper, sometimes use the feminine pronoun, and sometimes the masculine.

through the group forum, explain his ideas and their basis, making his critical articulation and defense of them. Thus, by the presentation of inadequate understanding or an initial conflict and subsequent negotiations, conceptual growth in students was promoted (Tolmie and Boyle, 2000). The tutor oversaw the development of the forum and intervened in situations where participants could not reach an agreement or where it was deemed necessary to clarify concepts and to strengthen co-constructed knowledge. At the end of the period of publication in the forum, the tutor made the comments she considered appropriate to reinforce concepts, and correct erroneous or confused conceptions.

At the beginning of the course students were introduced to the overall project that would be developed on the subject, and to the scaffolding activities that would contribute to its development, in the context of the teaching strategies defined.

The project statement was formulated in an approximation of the concept of situated learning (active, constructive and actual). The situation was affiliated with a particular workplace and enriched with the description of all the contextual factors that surrounded it, but not sufficiently defined (Jonassen, 2000). In this way, active student participation was facilitated, encouraging the search for real data, consistent with the situation and also offering the possibility of testing different sets of data.

In particular, the proposed problem described a training scenario in a company—a real estate chain—which required e-learning services for the management of informatics tools so that employees' individual and collective knowledge would make possible the resolution and improvement of processes or services. This activity required students to develop the proposal, based on distributed knowledge and collaborative work, learning strategies which, given the dimension of the problem to solve and the academic calendar deadlines, students also had to adopt in order to carry out the project.

In case of partial evaluation of the subject, students had to submit their draft accompanied by a general solution to the problem of overall training proposed at the beginning of the course. To carry forward the process of preparing the draft, two phases of work were designed (see Table I).

Table I. Draft stages

First stage (work in collaboration)	**Second stage (individual work)**
Based on work done during the course, students had to: • agree upon a solution for training and course design; • divide and assign to each team member the work unit to be developed. This activity had to be resolved by means of a forum on the group page. Frequency of participation in the forum, and quality of the contributions and referenced arguments were considered.	Students had to: • carry out the task assigned by the team and publish it on the Yahoo Group page (File > Partial >).

One of the goals of the course was related to the abilities, knowledge and skills students were expected to develop in training to become future instructors or online course designers. The training problems they would face constituted an archetypal example of ill-structured problems, since the instructor was conditioned by the circumstances of the practice context, and although in most situations, there were a variety of possible "good" solutions, had to make evaluations and assessments to select the most appropriate solution (Jonassen, 1997).

The expected production was a training proposal which would demonstrate the knowledge gained by the students, thinking as professionals, and not a project on the level of a professional experienced in e-learning.

Students had to define the problem and determine what information and skills were needed to solve it.

Instances of social interaction

A central issue in distance education is not where the teacher and student are, spatially, or how they communicate, but the quantity and quality of their interactions. The truly innovative role of new information and communication technologies in distance education is to try to reduce the transactional space between teachers and students, and encourage interaction among students (Hilman, Wills and Gunawardena, cited in Chen, 2001).

Considering that the forum provided adequate space to facilitate interactions (Anderson and Kanuka, 1997) student-tutor and student-student, in the first case motivation, feedback, dialogue and direction were offered to both sides; in the second, the exchange of experiences, thoughts, opinions and analysis was aided.

Thus, activities were designed to be developed through the group forum of the subject on Yahoo.

The activities were designed to strengthen the interactions between peers in two dimensions: one that allowed students to share knowledge; reflect, based on other opinions about their own and new knowledge; as well as how to their ideas and thoughts with a solid foundation; and another which would enable them to work collaboratively, involving the mutual commitment of the participants in a coordinated effort to solve a problem together. Social interaction played a fundamental role in the learning process, and therefore, in one of the pedagogical environments and tasks that would offer situations of collaboration with adequate support to promote, organize and coordinate participation (Moallem, 2003).

The teacher-student interaction was, moreover, mediated by electronic mail. The former acted as facilitator for the latter's individual learning process.

Implementation results

The work described here is characterized by its eminently social, because the proposed strategies are based on dialogic interaction processes around an activity, such as mechanisms of learning and knowledge building.

The word described here is distinguished by its imminently social character, since the proposed strategies were based on processes of dialogical interaction around an activity, as mechanisms for learning and knowledge construction.

The kinds of activities proposed, scaffolding and final project, required interaction between students—in the former, to evaluate it, and in the latter, to solve it collaboratively. Moreover, the social aspect was still present in the phases of autonomous interaction with the material, since students were guided and accompanied by the tutor.

From the records of emails and posts in the forum space, we analyzed the dynamics of the experience and degree of effectiveness of the proposal for the achievement of learning.

Scaffolding Activities

During the scaffolding activities carried out by the five students, there were 18 student-tutor emails, of which 44% were sent by the students, and the rest by the tutor.

One of the characteristics of this activity is that its correction is not individual tutor-student, but in a common space, the students must store the points of the activity indicated by the tutor, so as to participate later in the forum in a discussion about solutions presented by various members of the group.

At first, we observed some difficulties in students' understanding the work methodology, since, despite of repeated explanations, two students kept insisting on contacting the tutor for individual correction of the practice. Eighty percent of Student 1's posts showed this; while Student 2 had the smallest number of posts concerning it—about 33%. Also conspicuous was the absence of three students' interaction with the tutor through this medium. However, it could be inferred from comments posted on the forum, that there was student-student communication, which was left out of our records: "being able to consult both with both teachers and classmates at any time using the tools provided by Internet..." (Student 3).

Figure 1 shows the flow of interaction among students participating in the forum. Students are identified by ellipses (A1, A2, A3, A4, A5), address (sender/receiver) with arrows; the order (of publication in the forum) and the message type (agreement, disagreement, contribution, lack of understanding).

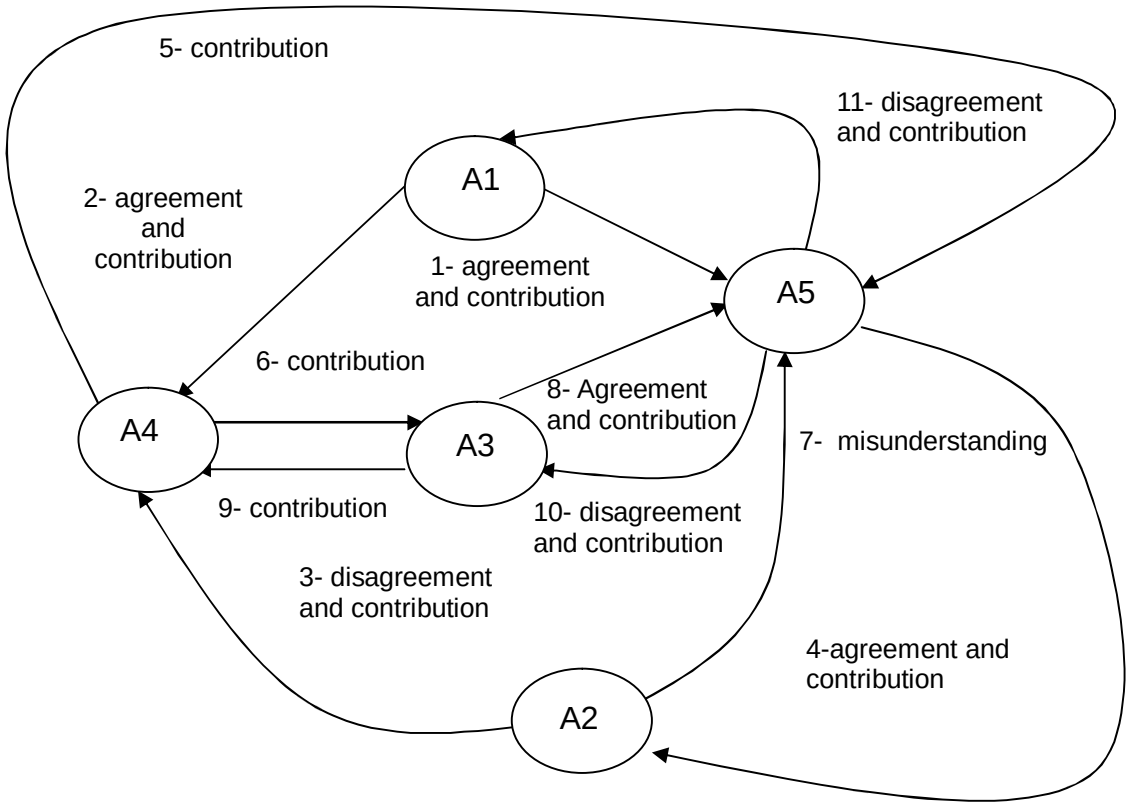

Figure 1. Flow of interactions between students participating in the forum

At this stage there was no smooth flow between the members; they merely responded as requested in the activity (thus at least two peers evaluated the solution); but all the points were discussed by at least one forum participant. Interventions were observed to be based on solid grounds, showing, on the one hand, appropriate interactions with the content and, on the other a recombination of the best elements of the ideas presented by the interactions between peers and

tutors to reach, finally, a reformulation shared by the group, of the object of knowledge of the learning.

In general, the quality of individual responses was good, showing that the structure of the materials and activities favored interaction with the content and promoted assimilation. The evaluations showed a good level of argument. They demonstrate that this type of activity promoted a high level of student commitment to the task. Perhaps this behavior was motivated by the requirement to "know", in order to evaluate a peer.

Final Project

The following describes the group's discussion dynamics for solving the training problem presented. This activity was resolved, as had been suggested, via a discussion forum. However, from what the students expressed in that forum, it appears that some synchronous encounters took place in a *chat* room: "... I propose to set a time to chat, so we can limit our decisions on the basis of what each one [...] Well guys, taking into account what we talked about yesterday *[chat]*, I did a presentation of the situation…see what you think ..." (Student 1).

During the eight days over which the forum was developed, students sent 20 messages, for an average of 2.5 messages per day.

In the first stage of forum discussion, it was focused on considering two aspects: a) organization and selection of content, and b) training methods and strategies, specifically for the final draft (second stage).

a) Initially each student published his content proposal for the training course. Student 1 suggested Office Suite and a web page editor. Student 3 proposed Office Suite, an Email management tool, a graphics application and a web page editor. Student 4 thought that the company was using a special, made-to-order software, and so proposed training in that tool and in a word processor. During the discussion the points the three students had in common were reinforced over time. Student 4 abandoned her position on specific software, and so made it possible to come to an agreement: "I just read what Student 1 published, and in general I agree with everything he brought up" (Student 4).

This issue was discussed in nine messages, and was expressed in the final draft as follows:

"... It is considered that these programs are satisfactory for the tasks to be performed by the employees: Word, Excel and Access. For this reason, training courses in these programs will be given."

While at first Student 1 gave up the idea of considering teaching a web page editor, and Student 4 had not chosen such a content, Student 3 continued to argue

concerning needs that would justify their inclusion. In the final draft, the agreement reached was reflected in the following paragraph:

> "Employees should be able to update web pages, but it would be a function that is now performed by more experienced employees—so it is not an immediate need. Once this initial training is finished, there could be courses given on web page editors."

b) The problem presented had to do with a company with several offices in different geographical areas. The students discussed the possibility of semi-presencial training for employees of the main headquarters and local city branches, and distance learning for personnel living in other cities.

Student 1 suggested two teaching modalities based on where personnel live:

> In the first case (only within the city), training could be done in two ways, one using the company's website, along with periodic meetings [...] In the case of having to train all the branches, that would be done only via Internet (because of the geographical location problem. You can't limit the presencial classes to one city), with a training space on the company's web site, where there would be theory classes, examples and exercises.

Student 3 gave his opinion:

> I think that if the company is presented to us as having offices in different cities, and if the training they hope to contract is at a distance, the fact that we are in the same city as the company or as one or more of their branches is irrelevant. Don't you think so? The training is presented as distance learning, not semi-presencial.

Student 4 tacitly agreed with Student 3's proposal:

> The first advantage is that employees work with computers, and these of course are always connected to the Internet; virtually asynchronous communication will have very little lag, and in a lot of cases, discussion or chat among employees is frequent.

Finally, the students opted for a distance learning project to meet the needs of the company's units: "Because of the geographical features (offices in different parts of the country), training will be done via Internet..."

Concerning the didactic design of the course, students agreed on the need for a proposal that allowed them to adjust the course content to each student's individual situation, based on the evaluation of their prior knowledge. For example, the opinions were:

> I think education should be personalized. Not even all the employees pigeonholed in a section should automatically receive the same training. It all depends, as you say, on prior knowledge and how easily they approach the suggested topics. You may need to reinforce with additional readings or exercises, according to whoever needs it (Student 3).

> Of course, everybody would be taught all the programs, but out of each program, only what they need (they will not be motivated to study things they already know). The courses would be carried out via Internet. The company has a space just for that on their web page. That's where you would find the courses and the module-student roll—I mean, what student is studying what part of the course. This is for what we said before, that we are going to teach only what they don't already know (Student 1).

> The course should be composed of the specific content so the employees would do their jobs the best way possible (Student 4).

In the final project, this idea is reflected in the following manner:

> The course has great flexibility because of being divided into modules; these include specific topics. It does not matter if the personnel know about a topic or not, or whether they perform all the tasks in the office or not; each student will have his or her specific modules, based on the personal interview conducted by the trainers.

Given that the discussion about the content and methodology of the proposal occupied most of the messages, the issue of learning evaluation was considered in a decisive manner. It could not be argued that students downplayed the issue, but rather, lack of time to agree on assessment strategies limited them to giving a brief outline of possible ways to evaluate.

This topic was considered only by Student 1: "The monitoring would be conducted via mail, *chat*, or discussion forums. The evaluations would be continuous, and would use mail. We could also consider the possibility of one final meeting, to evaluate the group".

This motion was tacitly accepted by the other two group members, who expressed it in the final project as follows:

> Each module will have its individual assessment, and a group assessment at the end of the course [...] In addition, we will continuously assess the progress of students, keeping track so as to answer possible questions and generate ongoing improvement.

As mentioned already, one of the main objectives in this area was to promote student reflection on the processes developed in production a training solution. Tutor interventions were the subject of analysis and reflection, since future teachers had to be prepared and trained to perform this role: "Tutor in virtual learning environments."

During the development of collaborative group assignments, the students identified and reflected on the role of the tutor. The following is an excerpt from the forum in the first stage of work, related to partial evaluation:

> As I understand it, because of the presentation of the problem, this training time must fit within the work schedule, and the company obviously agrees…and the

> time allotted for this training…I think that is something every employee must arrange with the company. We would handle it with a forum (like Gabriela [the tutor of the group] does), so that it does not control the amount of study hours, but our progress, instead (Student 3).

Concluding remarks

The paper describes the implementation of a didactic proposal for a project-based online course (Barron *et al*., 1998) and collaborative work (Bennett, 2004) as a core learning strategy for an academic module that addresses the problems of design and implementation of training courses using ICTS. Considering the principles proposed by Barron and the Vanderbilt Cognition and Technology Group (1998), there were designed learning activities that serve as scaffolding to acquire the knowledge necessary to permit the development of a comprehensive training project for an organization. Most of the tasks selected are real activities in real situations (Nardi, 1996), which require for their solution the use of knowledge and techniques that make up the curriculum of the subject. This holistic focus allows an approach, in simplified form, to the content and tasks, "not by means of fragmentation, but by the identification of versions more simplified and belonging to the real world" (Reigeluth, 2000, p. 452).

The reason for including collaborative work in this proposal was to create situations in which were generated productive interactions between students (and Eurelings Ronteltap, 2002). This notion of productivity required students to put into play strategies and higher cognitive processes, since they must evaluate contextualized situations, make decisions, propose solutions, negotiate ideas with arguments based on knowledge and build the proposal.

The results of this experiment highlight the benefits of designing authentic project activities, developed within a learning environment that incorporates a set of tools to support online communication for working collaboratively (web page, discussion group and Email). In the results were highlighted the construction of the tutor's functions, based on reflection regarding the performance of an *expert* (the course tutor) and his own performance as a distance learner (Collins, 1997).

The students showed a real commitment to the task, produced by the necessary interaction with others that requires knowing in order to participate; solving in time to discuss, present and defend ideas cogently, negotiating and even, in some cases, accepting the proposal of the majority.

This teaching methodology, supported by dialogic interactions, can enrich production, given that it organizes the individual contributions in a synthesis of ideas from all members of the group. In this way, it was noted that the collaborative work, as defined by Ingram and Hathorn (2004), consists of three key elements: participation, interaction and synthesis.

Project-based learning and working with computer support comprise a promising and imminent innovation in online education; these have not yet been sufficiently

exploited in the academic environment as mediating tools to expand learning, not only in space but in time (DeLacey and Leonard, 2002).

Educational institutions face the challenge of providing students with the knowledge and abilities that will enable them at the end of their formal education to adapt successfully to the problems they will encounter in their professional labors within today's technological context.

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