WEB BASED DISTANCE EDUCATION IN CHEMICAL INDUSTRIAL PLANTS

Armando E. De Giusti[1], Raúl A. Pessacq[2]

[1]Faculty of Computer Sciences. UNLP.
[2]Faculty of Engineering. UNLP.

Abstract. The development of ICTs (*Information and Communication Technologies*) and their application in Engineering Education (in a knowledge-centered world) is one of the axes of an ongoing educative transformation. In particular, when the objective is updating professionals and training the industrial plant personnel *at the work place*, the use of Distance Education tools is of utmost importance. The employment of "Web Based" technologies allows using an expert's know-how, without requiring his/her presence within the plant, which implies a methodological transformation in the learning and teaching process. The challenge to this transformation process is to acknowledge the resources to be used and measure their weak and strong points. This quality evaluation is complex, since it should encompass both technological aspects and learning and teaching pedagogical mechanisms. An analysis of the issues to be considered in assessing Web-based Distance Education Systems for the staff of industrial plants is presented. The axes for such evaluation are discussed, together with the presentation of different experiences in chemical industrial plants, for preparing technical personnel. Finally, the application of a specific environment for Distance Education (Web-Info), developed in La Plata University, is also discussed.

Keywords: Distance Education, Web Based Learning, Chemical Engineering, Information and Communication Technologies.

[1]Full-Time Chair Professor. CONICET Main Researcher. III-LIDI. Faculty of Computer Sciences. National University of La Plata. 50 y 115 1er. Piso (1900) La Plata - E-mail degiusti@lidi.info.unlp.edu.ar

[2]Full-Time Chair Professor. Department of Chemical Engineering. Faculty of Engineering. National University of La Plata. 48 y 115 (1900) La Plata - E-mail rpessacq@ing.unlp.edu.ar

1. Introduction

The continuous training of professionals and technicians working in the industry is a well known need, and this is usually done by means of their updating in specific subject matters. However, when the attendance to advance training courses is hindered or made impossible due to distances, geographical distribution, or work schedules, this need cannot be fulfilled with the traditional methods of educational centers. In addition, the times that professionals and technicians of the industry count with are usually not enough, nor the available timetables are the most appropriate for giving these courses. Litwin (2000)

On the other hand, many of the technical topics - specific to the industrial sector - requiring particular knowledge and developments cannot always be offered with the presence of the professor/expert in the places where they are required. Bransford et al. (2000).

These drawbacks can be efficiently solved by limited-attendance or distance education. This activity may count with a large demand on the part of the industrial market, and should be complementary to traditional (full-attendance) education of Professional and Postgraduate Up-dating offered by Universities.

Blended Learning[1] requires the physical presence of the teacher only in some instances of the course. As example, we can think of a 4-meeting model: at the beginning, in order to present the general objectives of the course and to establish an essential personal contact between the professor and the student; at an intermediate instance, to evaluate the tracking of the course content; a final class of conceptual closure of the course; and a possible last meeting related to the personalized evaluation of students' learning.

The quality of the text content, as well as how it is presented, plays a determining role in the potential success of the course. There do not exist immediate interaction and feedback, typical of a full-attendance course. Fainholc (1999)**.** The professor, expert in the specific topic, should then make a greater and more detailed effort when writing and presenting the contents.

These characteristics require that the distance course be long-windedly planned and presented, for which it is necessary to count with the knowledge of the different pedagogical, teaching-learning, evaluation, and computer design techniques. When attempting to develop a good distance course, it is advisable to build a group with a professor, a pedagogue, a designer, and an expert in the computer supporting tools, under the coordination of the expert in contents. Zangara (2002).

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[1] Blended Learning: learning process that combines limited-presencial education with non-presencial technology.

Experts in specific topics are usually scarce, and their availability is not always possible when the course demands require so. Proyecto ALFA Ceaticec II - 0221 - FI (2003). However, a text appropriate to distance education requirements can be built up almost without time drawbacks. The course can be thus repeated several times, with little need of the professor's presence in front of students though, as we shall see, with more time dedicated to their attention than in full-attendance course. Muilenburg, Berge (2001)

The professor's time availability, probable scarce, and the almost certain lack of time on the part of students, poses the need to carry out distance courses asynchronically, rather than with the time adequacy of traditional course. The student will have to be able to access the text whenever he/she can, study it and solve tests according to his/her rhythm, even though with certain limitations given by the professor at the beginning of the course, but he/she will have to be able to count with fast and daily access to make requests and questions to the professor. E-mails with receive acknowledge and with a response in the lesser possible term (within a maximum of 24 hs.) allow a reasonable asynchrony.

For the student, the course asynchrony should have, as counterpart, the daily availability of access to professors, who will count with a bigger teaching load than in full-attendance course. Burbules, Callister (2001).

In brief, technology allows solving some learning problems in the industrial environment, which requires an expert professor, with Distance Education resources. It is natural that the pedagogical result depends on the development of the material, adapting it to the context and to the new teaching and learning methodology.

1.1. Possible Technologies in Blended Learning

All throughout the 20th century, Distance Education has used the most varied technologies: books, guides, instruction guidelines; radio and TV (in particular in '60s and '70s); videos and audio tapes (in particular in '80s). From the PC and Internet, the '90s receives the impact of networks and e-mails.

In the '90s, Computer Sciences exploit these technologies and create new tools specially oriented to Education ranging from intelligent search engines to digital libraries, including languages and environments oriented to Distance Education processes.

In this way we reach these days, in which it is easy to notice the preeminence of WEB-centered systems that employ InterNet support. Abbey (2000), Chacón (2003), Rosenberg (2001).

WEB-based learning (though it requires technological resources of certain importance, not only on the part of the professor, but also on the part of each student) becomes universal and presents advantages that can be synthesized in the following points:

Higher richness in the formation process:

- Approaching complex and abstract concepts with higher language richness: sounds, animations, videos, simulations, hypertextual languages, etc.
- Encompassing more contents in the formative process: concepts, attitudes, and abilities.
- On line access to more information.
- Relieving the professor from tasks as deliverer of information and enhancing its role as orientator.

Higher motivation for learning:

- Students can asynchronically choose the place and time to study.
- Interactivity with contents, action-reaction with resources, game and discovering techniques allow the stimulation of students' interests.
- Stimulating the wish to improve oneself by means of learning with systemic auto-evaluations.

Communication among the protagonists of the learning process:

- Ability for solving doubts: higher accessibility to professors.
- Easing learning by interchanging opinions among equals and professors.
- Better tracking of learning and teaching processes.

1.2. Transformation of Full-attendance Courses into Blended Courses.

The complexity of a Blended Learning system. There at least four subsystems inherent to Distance Education: Material Production, Students and Professors Management, Tutorings, and Evaluation. In turn, each of these subsystems requires a computer support of an environment or a coordination subsystem. Sanz et al. (2003).

Naturally, from the point of view of the traditional professor, a blended-course management is more complex. In addition, migration or transformation of a course prepared for the classical full-attendance model into the use of Distance Education technologies implies a process requiring new knowledge and abilities on the part of the teacher and, in many occasions, the support or

participation of experts from other disciplines (pedagogues, graphical designers, computer specialists).

The tasks of the professor/expert. The development of materials is the essential component of the professor/expert's job. However, he/she is now faced with a technological environment which obliges him/her to re-develop not only the components of his/her classes but also how he/she is going to present them, the interaction methodology with students, and the maturing process leading to the final evaluation.

The professor (though he/she leads the presencial meetings) does not "give" classes: he/she should prepare the elements so that the student builds his/her own learning process, from a "classroom + library + virtual laboratory" provided by a computer environment.

It is interesting to notice the transposition of the role he/she is now in charge of: he/she should place him/herself in the role of "potential student" in order to develop the material (and its presentation) in function of what the possible responses of his/her virtual audience would be.

On the other hand, the deep knowledge of the potentialities of the technological tool will provide him/her with a quality differential when developing the contents, which is not exactly related to his/her knowledge nor with its expressive capacity.

The role of the tutor. Many times, the very professor/expert will supervise the interaction with students and will be in charge of the tutorial assistance. In other situations, this is impossible (due to the number of students, or how busy he/she is).

However, the role of the tutorship is of utmost importance because in its execution lies the interactivity that can be accomplished with those students working asynchronically.

The pedagogical training in tutoring techniques, the involvement of the necessary resources to minimize response times to students, and a deep knowledge of contents and potential doubts allow professors/tutors to add a certain value to the contents of a course. Duggleby (2001).

In a virtual environment, the connection of the student learnt with "the real professor" is the response received by professors/tutors. Beyond contents, the situation of questions in the classroom, and its enhanced effect on the class and on the person who utters the question, repeats itself: only the teachers who are capable of converting these doubts in a learning situation will succeed in their courses.

Evaluation Process. Even though the type of experiences carried out keep the final presencial evaluation, it is important to understand that a Blended system requires a *process* of evaluation that implies a continuos learning tracking of students.

Technological tools provide new resources and, at the same time, require from the professor who carries out the course tutorship a personalized tracking of each student, in order to avoid large gaps in the learning process. Haladyna (1999), Hanna et al. (2000).

The transformation of full-attendance courses into blended courses thus entails a complex process, for which there *do not exist* proved systematical methodologies.

Although a Blended Learning system supported by new technologies counts with a series of advantages for professors and students, its greater complexity requires another training on the part of professors and new skills on the part of students.

It is really useful to build a multidisciplinary group when developing materials and also when tracking tutorships (content specialists, pedagogues, designers, computer specialists). All the members of the group should count with a deep knowledge of the technological tools that they will use and a pedagogical support of their employment in every case.

1.3. The case of process industry or chemical plants.

Process industry provides an environment of great interest for Blended Learning experiences, due to the difficulties with the plant personnel's training within their working hours and due to the requirement of experts in specific subject matters.

This paper analyzes two distance courses carried out by professors of the National University of La Plata for an important pretochemical plant of the area: one for engineers of different plants and countries (geographical incompatibility), and another for plant operators and dispatchers with rotating working shifts of twelve daily hours (time incompatibility). Iglesias et al. (2005).

Experience 1. The first course, about "Basic Operations of Chemical Engineering", was oriented to process Engineers with basic knowledge of spreadsheet use. The objective consisted in providing students with tools and methodologies for the design of new units or the analysis of the existing ones. The student group consisted of a group of plant engineers with different level of experience and a wide geographical distribution.

As integrating activities of the basic text of the virtual classes, we had to carry out an important computing task, in which the use of spreadsheets proved to be of great efficiency. These activities produced an interruption in the tracking of the text, since they had to be finished in order to continue with the course. This allowed achieving sequentially and strengthening in knowledge acquisition (as a result of the computations) and evaluating students almost continuously.

In some works, we had to recur to the assistance of add-ins developed in languages available in the spreadsheet; as example, Visual Basic for Applications available in the market or in Internet. The use of these add-ins allowed us to carry out activities of Conceptual Design, with open problems, i.e. with several possible solutions which require the application of theoretical and practical criteria in order to carry out the best choice of possibilities. The use of add-ins translated intricate computing problems, focusing the activity on the conceptual analysis of results and alternative selection.

The graphical part constituted an important segment of the text, even though, given the characteristics of the subject matter, it required low complexity when using the complementary tools.

From the delivery of the course, we could appreciate that distance generates a personalized relation between each student and the teacher through private communication channels (e-mails), with less acceptance of debate forums. This increases the quantity of individual queries (and this fact is not usually present in presencial courses) maybe due to the anonymity in front of the rest of the students, thus substantially increasing the tasks of professors. It is worth to mention that this result seems to contradict the opinion that holds that distance courses are a good response to massivity.

There existed certain difficulty when evaluating the proposed papers, since students did not present them at the same time, and also due to the different times dedicated to the analysis and comments required by the results. We were then obliged to recur to fixing some compulsory norms in order to systematize an activity schedule so that the course could evolve, without much additional effort on the part of professors.

Experience 2. The second course, "Control Process", was developed according to a specific demand of the company, which consisted in training operator and dispatcher plant technicians. This course was required to be hold during the working hours, with rotating shifts, within a period of two months, with weekly activities, and three presencial classes at the company. It was based on the personnel's secondary technical knowledge and on practical experiences in the management of specific petrochemical plant.

The text was developed carefully and slowly in order to adapt it to the capacity and studying possibilities of the assistants, i.e. almost without formulas, with enough explicative graphics, and without computations, so that it allowed acquiring knowledge that could be reflected in a better working quality. For this, the plant in question had to be analyzed and part of the text was referred

to it, and, on the other hand, it involved the students' rich and empirical experience. In order to fulfil these requirements, we recurred to the confection of a state personal diagnosis, performance and problems of the plant, referred all to each one of the topics gathered in the 10 (ten) modules of the text. This diagnosis analysis resulted in a really rich outcome, both in terms of the concepts and problems interchange with the professor and in terms of the participation and involvement with the quality of what was presented. The final result of this way of evaluating and tracking the acquired knowledge constituted one of the greatest successes of the course.

As evaluation of the course content learning, we carried out tests in the form of individual multiple choice.

The level of queries made to professors – the e-mail was the only enabled - was low since students worked in groups in the shifts of the company, all of which generated studying and consulting among them. Hence, in the presencial instances, internal work circuits could be detected, with different hierarchical and speciality levels, which helped strengthening the joint work of the personal. Diagnosis and tests evaluation indicated that this group activity (not initially sought) eventually constituted a positive fact for the company, since the natural leaderships of each group were reinforced.

It can be considered that both courses were successful, given the results of their quality evaluation on the part of the assistants and companies. It should be noticed that they were developed according to the specific requirements of the companies that asked for them, a fact that highlights the role of professors in relation to theoretical and practical knowledge of the topics dealt with. The computer resources of the two platforms used, as well as the graphical resources and add-ins, had to be selected according to the assistants.

This type of Control Processes course constituted the only way to train the plant staff during the working hours in the company, which showed the utility and efficiency of Distance Education, applicable to similar cases.

The use of a Distance Education platform (in this case Web-LIDI developed by the Faculty of Computer Sciences - UNLP) proved to be of great use for this type of problems. The employment of the virtual environment facilities enhanced students' activity and allowed a personalized tracking on the part of professors.

2. Conclusions and Future Lines of Work

Blended Learning using WEB-centered technology for handling the concept of "Virtual Classroom" with students is extremely useful in the industry when training actions are posed directly "in the plant", with asynchrony timetables and students geographically dispersed or with certain heterogeneity of previous formation.

Blended course are highly demanding in terms of the development of materials and professors' attention (more than in a full-attendance course), reason why a careful planning of all the activities is required, as well as the availability of a working platform with the proper facilities.

A multidisciplinary work is implemented, so as to support the professor/expert and solve the aspects not related to his/her specific knowledge, such as the design or exploitation of certain computer resources.

The transformation process of full-attendance courses into blended course is complex and essential for the success of distance learning.

In many cases, for courses in the are of Chemical Engineering, utility office programs (for presentations, computations, data bases) make up a software set proper for the development of the didactical material of dynamic characteristics, over a suitable virtual environment, so as to modify the passivity inherent to a lonely learning and based on textbooks reading.

It is of utmost importance adopting norms to structure the presentation and the activities schedule proposed throughout the course, in order to ease the tracking and marking on the part of professors. Presenciality and individuality of the final evaluation are hard to replace.

The collaborative learning scheme is suitable for training environments, both of technicians and Engineering professionals. "Open" problem formulations contribute in the formation and tasks of these groups.

The current lines of work are related to the incorporation of "Virtual Laboratory" tools in some specific courses in order to clarify situations modeling and to add to the WebLIDI environment a synchronic and coordinated communication tool for a reduced number of students and with direct control of assignments and timetables on the part of the professor. Ricci et al. (2005).

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