Analysis of Web Based Learning use in a First Course of Algorithmics

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ABSTRACT

This paper presents an analysis of the aspects to take into account when reformulating the teaching and learning processes of a first course of Algorithmics employing elements of Distance Education in a Web-based virtual environment.
Particularly it analyzes a large experience (more than 1000 students) carried out in the initial subject of Algorithmics (Computer Programming, annual subject), of the School of Computer Sciences at the UNLP, on three different student's profiles.
In addition, this paper discusses the difficulties of distance education on subjects with an important experimental component, such as the analyzed first course of Algorithmics.
Finally, the results obtained in the initial evaluation of the different student profiles are presented, analyzing the advantage and disadvantages of using these technologies in the initial graduate courses on Computer Sciences.

Key Words: Distance Education, WEB-focused Learning, Algorithmics, Information and Communication Technologies.

1. INTRODUCTION

General Aspects of ICTs and Distance Education Use

The use of ICTs tools is growing in education. [1] [2] [3] [4] [5]. In formal university education, every discipline is currently making use of the facilities of the new technologies in several ways.
Besides, the learning process of these tools entails a deep educational transformation, from the teaching and learning methodologies to teachers' training and recycling [6] [7].
The development of limited-attendance or distance teaching is of great significance. Indeed, Distance Education is a fact in our Universities and in many other areas of professional training and updating [8] [9] [10].

Distance Education may require the physical presence of the teacher only in some instances of the course, or he/she might just be a complement of the regular attendance activity. The whole distance activity is conditioned by the quality of the contents organized by the teacher-expert, the interaction tools available to teachers and students, the customized and close tracking during the activities and the student's requirements [11] [12].
These characteristics require a proper planning and presentation of a course with Distance Education elements, based on the knowledge of pedagogical techniques, teaching-learning, evaluation, and computing design. Usually, these requirements lead to a multidisciplinary-team work. [13] [14]. The course asynchrony for the student should have, as counterpart, the daily availability of access to the teacher, who will have a higher teaching load than in full-attendance courses. [1]
In brief, Distance Education may be a really valuable educational tool in university teaching, either as a complement to regular activities in the classroom or as a solution for physical-distance problems between students and teachers. Experiences both in undergraduate and graduate courses suggest a kind of blended learning combining attendance and non-attendance, and require the development of computer tools pedagogically supported in order to ease the mediation in the teaching and learning processes. [15] [16] [17][18].

Distance Education Technologies

During the twentieth century, Distance Education made use of the most varied technologies: books, guides, guidelines; radio and TV (particularly during 1960s and 1970s), video and audio tapes (during 1980s).
From the PC and the Internet, the 1990s received the impact of networks and the E-mail.
In the 90s, Computer Sciences exploited these technologies and created new tools specially oriented to Education, which range from intelligent searchers to digital libraries, including languages and environments oriented to Distance Education processes

At present the preeminence of WEB-focused systems, employing InterNet support, is more than clear. [19][20] [21] [22] [23].
Nowadays WEB-based learning (even though it requires that both teachers and students have some technological resources) is universal and presents advantages which may be summed up as follows [24]:

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Greater Richness of the training process:
- Becomes closer to complex and abstract concepts with greater language richness: sound, animations, videos, simulations, hypertextual languages, etc.
- Tackles conceptual and procedural aspects together, in order to generate new skills and abilities when acquiring concepts.
- Eases the teacher's tasks as deliverer of information and strengthen his/her role as orientator.
- Facilitates the development of strategies and abilities for the student

Higher Motivation for learning:
- Students may asynchronically choose the place and time to study.
- The interactivity with contents, the action-reaction with the resources, the simulation techniques, and the discovery allow stimulating the student's interest.
- Stimulation of personal growth by means of systemic self-evaluation learning.
- The student feels individualized in the classroom, and this generally encourages for personal growth.

Communication among the actors of the educational process:
- Ability for solving doubts: higher accessibility to the teacher.
- Facilitation of the learning process through the exchange of opinions among peers and the teacher.
- Better tracking of the learning and teaching processes, both for the teacher and the student.

Student - Distance Education Technologies relation

It is difficult to make generalizations about WEB-based distance education applications due to the features of each subject and the different working and academic formation methods of students. However, the use of technological tools within the scope of Computer Sciences university teaching has the advantage of the natural predisposition of students to acquire this type of technology and its motivation to use it.
Besides, specially during the first years of a undergraduate Program, students require a certain systemization of their organization and working methodology, which is eased in the full-attendance scope. For this reason, the use of distance technology demands a highly personalized Tutoring task (with limited-time responses) in order to keep a direct relation with the student.[12] [25].
On the other hand, the massiveness and heterogeneity of students of the initial courses of algorithmics are an incentive to explore the possibilities offered by ICTs and, in particular, Distance Education to favor the teaching and learning processes.

2. STUDENT'S PROFILES IN A FIRST COURSE OF ALGORITHMICS

This paper identifies three basic profiles of students, for which a type of distance task has been defined. In the end, all the students have the same evaluation level as well as an equal marking scheme.

Profile 1: Freshmen Students who passed PEA evaluation
- For those students who took the Introductory Course and passed the compulsory test (non-eliminatory) of Problem Expression and Algorithms (PEA), a course combining full-attendance and distance education was defined [27]. The student attends theoretical and practical classes, but he/she also has to develop additional distance activities using the WebInfo environment [22], with virtual tutorings for consultation and evaluation.
- It is a relatively reduced students' subgroup (about 20% of the entering students – 140 students in 2005). Usually, they are highly motivated, and Tutoring is mainly focused on theoretical topics with additional material, extended practical exercises, and self-evaluations. The demands related to practical works, which will be the axis of the evaluations analyzed during the experience, are similar to the rest of the profiles [26].

Profile 2: Freshmen Students who failed PEA evaluation
- For those students who took the Introductory Course and did not pass the compulsory test of Problem Expression and Algorithms, a regular regime course was defined. In this course, students attend the theoretical and practical classes and may make use of the additional material in WebInfo, but unlike those of Profile 1, their distance work is not systematically tracked and additional activities are not defined either.
- It is a large subgroup of students, about 500 in 2005. Usually, they are undergoing an adaptation process to the University and the results of the remaining modules of the Introductory Course (Computer Organization Concepts and Mathematics) also reflect some difficulties. In this profile, the attention is focused on full-attendance courses of 4 shifts, in 16 groups and with a Teaching Assistant each.

Profile 3: Returning Students (taking the course for the second time)
- On the other hand, an interaction with those students taking the course for a second time was expected, in order to identify the factor of initial failure and avoid their desertion after the first year. This group includes those students that for several reasons are taking the course for the second time. For instance, they have failed the first partial test of the subject, have failed the second one or given up the course for various reasons. This group may opt for attending the full-attendance modality (conditions similar to that of Profile 2) or develop a limited-attendance course in which all the activity (theoretical and practical) is carried out using the WebInfo environment with personal meetings in order to strengthen virtual Tutorings [29].
- It is a really large subgroup of students, about 400 in 2005, of which 75% have chosen the limited-attendance modality.

In all the cases, the WebInfo virtual environment has been used, since it offers facilities for accessing the contents, group work, communication, evaluation, and customized tracking. The contents of the subject are the typical ones [30], and their development requires 8 hours per week and full-attendance for 32 weeks.

The use of Distance Education would offer the possibility of attempting an adaptation approach to the different

profiles, keeping a close teacher-student relation by means of customized Tutorings.
This paper expects to sum up some of the results and difficulties of the experience (still under development).

3. ANALYSIS OF TUTORINGS AND REQUIREMENTS FOR THE DISTANCE EDUCATION ENVIRONMENT

If the context in which these experiences are carried out is to be analyzed, the fact that Computer Sciences is an applied science which requires a combination of theoretical research and applications, and that it is generally difficult to reproduce the analysis and design environments over a virtual environment should be taken into account.
In this discipline, laboratory work on different processing architecture models can partially be reproduced by means of distance links or simulations in a cooperative environment.
These aspects lead us to carry out a careful analysis of the minimum requirements to use a Web-based learning environment.
In general, Distance Education environments have several significant facilities to allow for the development of the teaching and learning processes [31] [32] [40] [33]. We will not analyze these facilities in detail, though we will make clear that, in our experiences, an own WebInfo [34] environment has been developed, which is being used in several Universities of Argentina.
We shall stress some additional requirements which should be considered in this type of environments, to be used in subjects such as this first course of Algorithmics:

Interaction Mechanisms with the Teacher:

- ✓ Apart from the asynchronic communication typical of tutorings, it is important to have synchronic communications with reduced students groups (supervised chat models) and combine open and synchronic activities, such as videoconferences, with open and asynchronic activities, such as thematic forums. In some cases, experimental practical works (algorithms- resolution type) may be self-verifiable from the environment (for instance, with algorithm visualization mechanisms) and be reviewed in a synchronized manner by teacher-tutors.

Remote Access to Laboratories

- ✓ It is ideal for students to make the connection "from the platform" to the Laboratory for the development of concrete algorithms. In this way, there exists a shift from the "virtual classroom" environment to that of online work with machines or physical networks available in the School. Here the quality of available links is critical, but the development of communications increasingly eases these possibilities, which recreate the Lab environment for distance students.

Real-time Supervision of experimental tasks

- ✓ The combination of the last point with the availability of a teacher capable of monitoring (from the virtual environment that coordinates distance activity) the student's experimental activity eases the correction of operational errors and the formalization of the experimental method with the equipment (relatively simple in the case of an Algorithmics course, though really sensitive in advanced courses). Notice that this facility requires incorporating certain complexity to the classical module "of the teacher" within a platform such as Web-Info and the like.

Collaborative Distance Work

- ✓ The tool should allow the students to work in teams or commissions, synchronizing activities among them, independent of the supervising tutoring activity or chat previously mentioned. Usually, these facilities are not available in the classical platforms of Distance Education, but they are necessary for the professional profile defined in Computer Sciences.

In short, the mentioned extensions show us the need to deepen the development of technological tools rendering the context of Virtual Classroom + Experimental Laboratory, with teacher supervision, and the development of extensions in DE environments in order to consider team work with/without teacher supervision.
On the other hand, *even when we have all of these extensions*, it is evident that a fundamental aspect for the success of the learning process is the *relation* established between the professor and the student. In a full-attendance environment, that relation is natural when the teacher observes the students' attitudes and behaviors; on the other hand, in a distance environment, the professor/tutor is the one in charge of making the greatest and best efforts to achieve a proper communication.
The tutor is now the support representing the visibly human face of this process. He/she should have the necessary skills to grasp the students' expectations, needs, and reactions, and to take part in the academic and pedagogical feedback process.
For this reason, in this experience, the greatest effort is focused on the development of tutorings -compulsory and optional virtual tutorings, full-attendance and distance tutorings - so that the student is able to constantly perceive the "presence" of the tutor/professor in his/her learning process.

4. STUDENTS NOT LIVING IN LA PLATA

Even though it is not part of the analysis of results presented in this paper, the beginning of limited-attendance activities of the School of Computer Sciences (UNLP) in places far from La Plata is of great importance, such as the 2005 Computer Analyst courses in Tres Arroyos (Province of Buenos Aires).
The implementation of this first course of Algorithmics has demanded the use of distance tools, mainly customized tracking over the Web-Info platform and videoconferences. This is combined with a weekly meeting of teachers in Tres Arroyos.
In this context, in which the student spends large periods working independently, the learning environment he/she will use and the planned tutorings will play a fundamental role in achieving the expected goals of the course.
For this reason, the model of Profile 1 previously described has been chosen for these students, giving special importance to team work using the Collaborative Work Area of the Web-Info platform, taking advantage of the solutions developed by students and allowing them to be shared by other students of the course, upon the tutor's request [36].

Also, the Area of Communication is being used, taking advantage of the possibilities given by the environment as regards the Message and Bulletin Board services. The use of these tools aims at providing the student with a space of communication with the tutor and other students as well as having the latest news of the course announced by the tutor or his/her mates. These tools used in the proper way make the student feel integrated to a traditional learning environment. [37].

5. RESULTS BY PROFILE

- ✓ Students of Profile 1 (as expected) obtained the best results in the first and second partial tests of the subject. The percentage of attendance to evaluations was high (about 90%) and the passing rater was of 70%, with a passing scope (there are three evaluation tests left) of about 100 % [38][39].

- ✓ A significant result was that the students corresponding to Profile 1 who opted for not doing additional tasks and working according to Profile 2 obtained results higher than the mean, but lower than those of Profile 1 (75% of attendance, 45% passed, with a passing scope of 80%).

- ✓ Students of Profile 2 obtained the worst results, with a 55% attendance rate and less than 11% of approval. The passing scope is about 25%, which is under the course mean.

- ✓ The analysis of the two populations corresponding to Profile 3 is of utmost importance: returning students who opted for the limited-attendance course obtained a 61% attendance rate and 36% of approval. Those adapted to Profile 2 (making the attendance course for second time) obtained a slightly higher attendance index and almost identical results: 37 % passed.

- ✓ The surveys made to limited-attendance students reflect their approval of the adopted model and make no difference with the other subjects of the first year taught under the "classical" model.

- ✓ Being the results globally analyzed, the general results are within the historical mean for Entering Students, and reflect a slight improvement for Returning Students. The permanence possibilities of students who constantly interact with the teacher via the virtual environment seem to be better (which is reflected in the attendance to evaluations – really higher than the mean).

6. CONCLUSIONS

This paper has presented an analysis of the aspects to be taken into account when there is a proposal of reformulating the educational process which makes use of Web-based environments, specially a process which makes use of DE methodologies and tools in the first course of Algorithmics in the Computer Sciences Program.
An important experience in the first year of Bachelor in Computer Sciences of the UNLP has been analyzed, highlighting the results related to the three students' profile.
Also, the necessary extensions in a Distance Education environment for attending courses requiring certain experimental or lab work have been presented.
We are currently analyzing the problems of students not living in La Plata, and working in the development of different extensions of the Web-Info environment, analyzing the interests of the chairs who make use of it.

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